THE TECH ENGINEERING NEWS

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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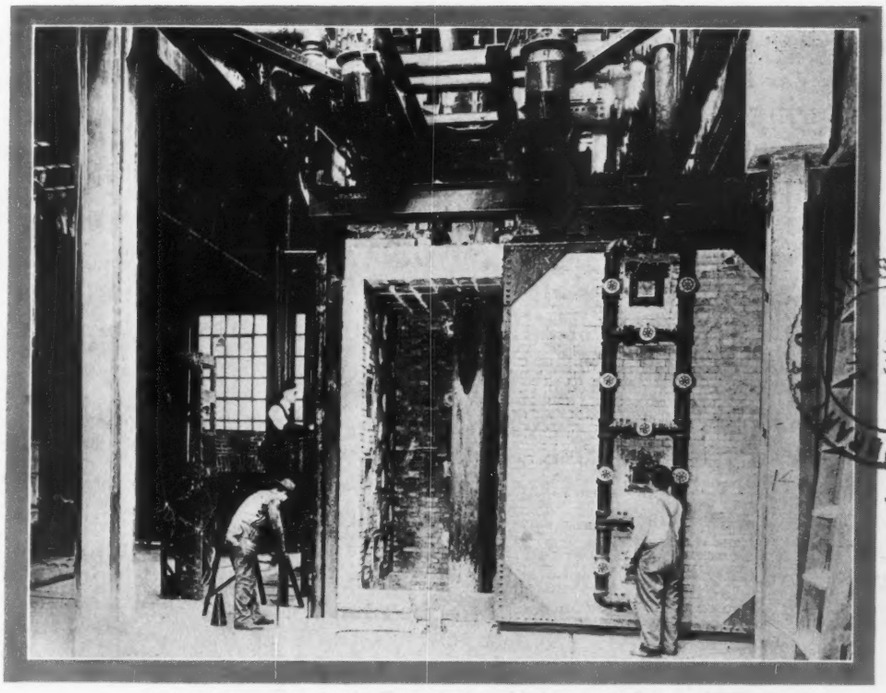
MARCH, 1924



TESTING THE RESISTIVITY OF COLUMNS TO FIRE

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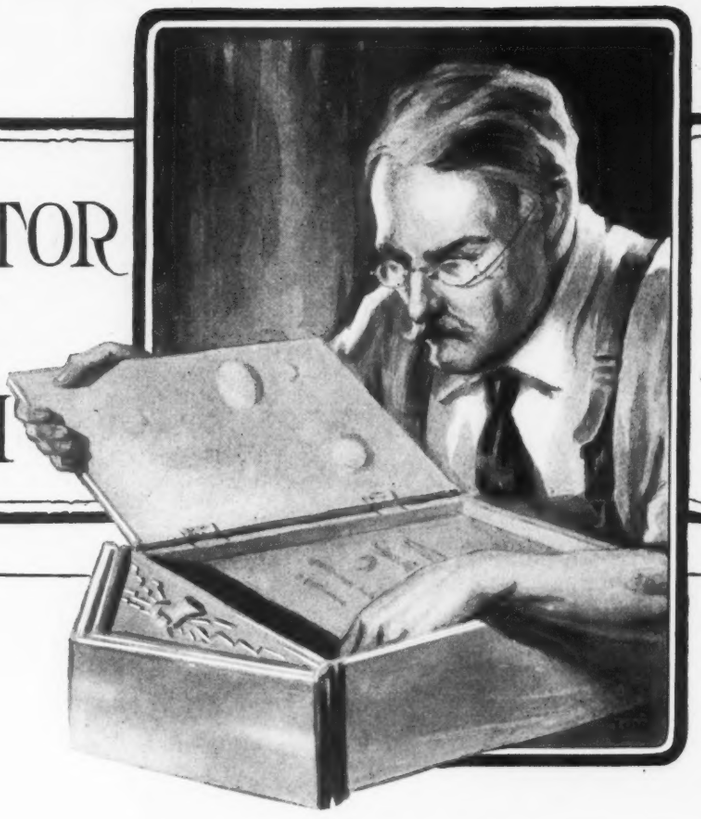
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS

AN INSPECTOR AT EVERY WORKBENCH



INSPECTION of fire alarm apparatus presents a different manufacturing problem from most other pieces of mechanism. Automobiles, engines and other apparatus are in use fairly constantly and defects usually are discovered before serious conditions arise. Fire alarm apparatus on the contrary is not subject to continuous test. A box is installed on the street and may not be used for months. When it is used, however, it must function properly because failure may result in the loss of millions of dollars or the sacrifice of a number of lives.

¶ Fire alarm manufacture is highly specialized and a good workman usually stays with us for many years. These men appreciate the responsibility that rests on the apparatus which they build and each man is virtually an inspector of his own work and the work that has been previously done. It is this type of workmanship that has given us the confidence of the fire department officials all over the country and has resulted in Gamewell Systems being installed in the great majority of cities throughout the country.

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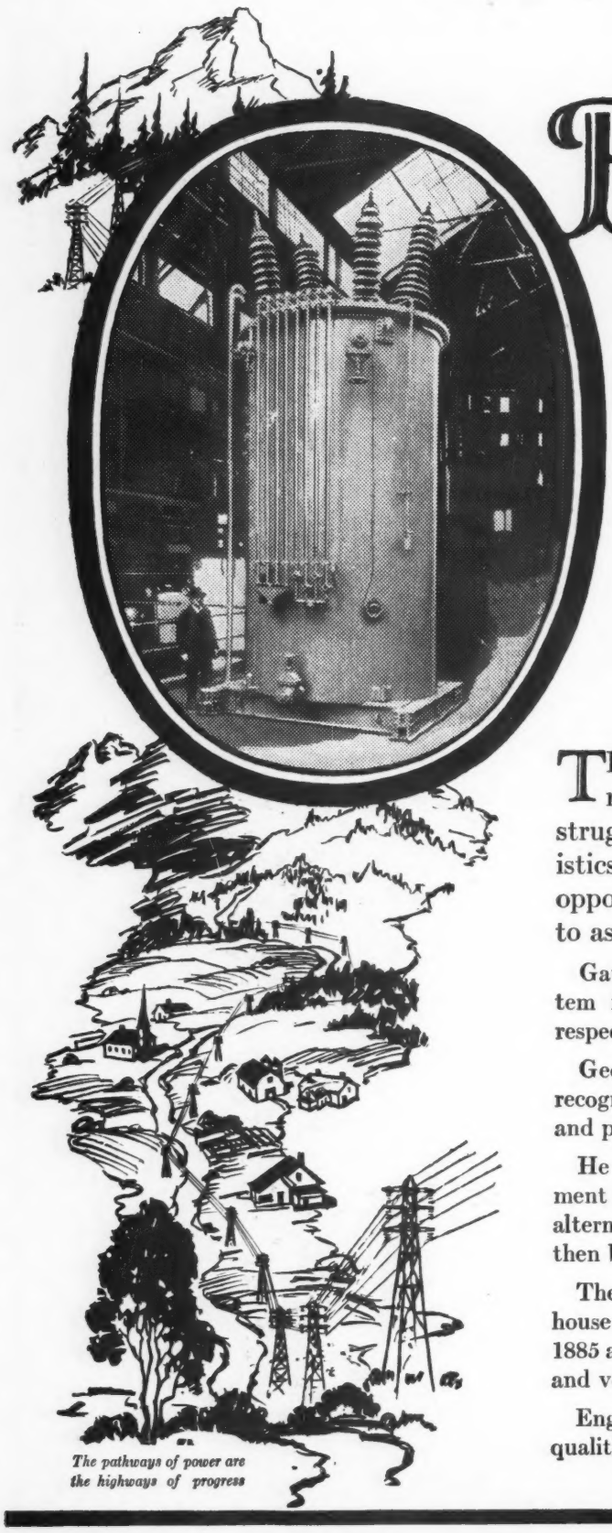


The pathways of power are the highways of progress

Before Alternating Current Dominated the Electrical Industry

What Engineering Owes to the Far-Sightedness of George Westinghouse

THE impregnable position now occupied by alternating current was attained only after a bitter struggle, for, due to its supposedly deadly characteristics, practically the entire electrical fraternity once opposed the progress of what was generally referred to as "Westinghouse Current."

Gaulard and Gibbs originated the alternating current system in Europe. Their system was impractical in many respects, but had been used with some success for lighting.

George Westinghouse became interested, and immediately recognized that the weakness of their system lay in the design and principles governing the transformer.

He devoted the resources of his organization to the development of the transformer. When he made it a practical unit, alternating current, with its vast commercial advantages, then became possible.

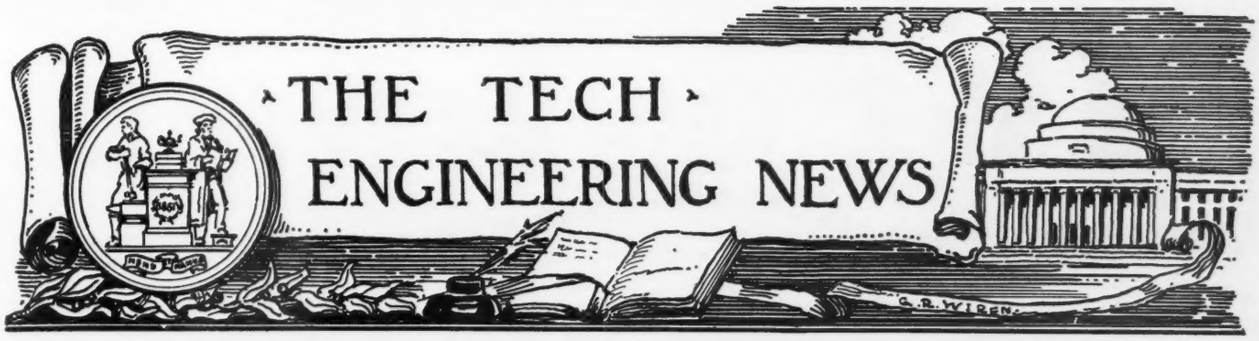
The beginning of the bitter struggle by George Westinghouse for the supremacy of alternating current goes back to 1885 and 1886. Remarkable progress has been made since then and voltages as high as 220,000 are in commercial use today.

Engineering owes much to the far-sightedness and fighting qualities of George Westinghouse.

Westinghouse

WESTINGHOUSE ELECTRIC

ACHIEVEMENT & OPPORTUNITY



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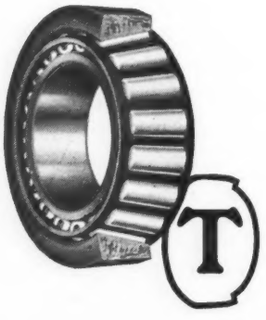

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THE TECH
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME IV MARCH, 1924 NUMBER 9

THE ENGINEERING SALESMAN*

By E. H. SNIFFIN

In Charge of Central Station Business, Westinghouse Electric and Manufacturing Company

WHAT is the engineering student going to do when he leaves college? What is to be his career? Why has he studied engineering? Is the engineering profession his objective, or does the field of business present the most attractive possibilities in which engineering knowledge and engineering training will be of value to him? If these questions could be pondered and answered, and answered correctly by the graduate, how many tragedies would be spared us of men starting on the wrong career, of being misplaced. Many a good engineer has been spoiled in attempting to be something else, and many a man has remained in engineering work who had the talent for greater world service in another direction.

There have perhaps been more mistakes made in the field of selling than in any other occupation. That is the average man looks upon selling not as a profession in itself, requiring very definite qualities of character, personality and temperament, but rather as perhaps the most pleasant occupation he could think of. For want of doing something else, he thinks he could sell. He likes the idea of traveling around the country, meeting various people, stopping at good hotels and, in general, occupying himself with the social side of business life. And it is due to this wrong conception of selling work and to the fact that so few people realize what the requirements of a good salesman are, that the percentage of real salesmen is so small. It is a fact that the managements of our large industrial organizations admit very freely that, among their various branches of service, the good salesman is the hardest man to find.

Are you a salesman? That is a very pertinent question. You either are or you are not. If you have the inherent ability, then you will need much training and much experience to reach your full size. When you sell, you are dealing with men, not with things. Every man you meet will be different from every other. You will not be dealing with a concrete problem involving known substances, weights and dimensions, but you will be dealing with human nature in all its myriad forms, with a wide field before you in which to exercise your imagination and your resource. The result will always be uncertain, but you must be fond of this "game of chance", so to speak — the game of getting men to do what you want them to do. The books are full of precepts on salesmanship, but one thing they fail to say is, that unless you have that love for the chase, that houndlike instinct for going out and getting the order, knowing how to win, and also how to lose, feeling the tremendous lure of the uncertainty of it all, then you will remain in the rut of mediocrity, and although you may be called a salesman, yet you will be nothing of the kind. What was it the Man of Galilee said to Peter and Andrew when He wanted them to be his disciples? They were fishermen. He said, "I will make you fishers of men". What He meant was that He had certain great convictions that were to be implanted in the hearts and minds of mankind, and He wanted men who could go out and plant those convictions. And these men, believing in their product, and thrilled with their mission, went out and fished for men, just as a real salesman does today. And they had good preparation for their exalted salesmanship. They had been fishermen. Everyone who fishes, or tries to catch fish, is not a fisherman. How many people there are who try it! They fish for awhile, have little or no luck, reel in their lines and start for shore. Your real fisherman hangs on; tries one lure after another; fishes at different depths; floats over a shoal and then across a weed-bed; works the boat close to a sunken rock, studying the habits of the fish, having the time of his life even when he catches nothing. But he is the man who brings in the fish. That is the way a real salesman goes about his work. He loves to sell. Defeat doesn't make him sore, doesn't make him dislike people. The harder they come, the better he likes them. And when he gets them, oh boy!

We are speaking of the spirit of selling, for if the spirit isn't there, you had better keep out of it. The salesman was once the fakir in the bazaar, the trickster. *Caveat emptor*, let the buyer beware, was the philosophy of his calling. And even yet we sometimes think of the salesman as a slick gentleman whom we must be careful to watch. Well, if he gives you that impression, he is no salesman at all. And don't you ever try to be a salesman yourself unless that truth is in you. You must believe in the thing you are selling; first buy it yourself before you can sell it to others. And your work of selling is a work of dignity. Make it so. You are your company's voice. Don't forget that. A serious-minded, good-natured, optimistic, enthusiastic, imaginative man — that's what the salesman should be.

But few words are required on the mental qualities of the salesman, and on his character and moral qualities. It goes without saying, that he cannot get very far if people question his character or if his moral fibre is at all weak. He is in contact with all kinds of people, under many different conditions. His working hours are of necessity irregular. He is away a good deal and somewhat removed from the orderly processes of community life. Compared with the man who travels to and from his work at fixed hours,

(*Continued on page 380*)

* Note: The second of a series of four articles contributed by Westinghouse Electric and Manufacturing Company in the hope that the information presented may be helpful to engineering undergraduates in analyzing themselves in relation to the engineering profession.

RELATION OF STUDENT TO INSTRUCTOR

By PROFESSOR L. MAGRUNDER PASSANO
Associate Professor of Mathematics, Massachusetts Institute of Technology

IF we use the word relation as it is so often used in our mathematics classes, the relation of teacher to student at the Institute, or anywhere, may be written as a formula — *not* in "the manual": teacher: student:: *x*:*y*: and, of course, having a formula for it we know all about it. The only trouble is that our formula contains two unknowns, x and y, and unless we can determine them in some way our formula tells us nothing.

What is x and what is y? It would seem that x is all the qualities or characteristics, physical, mental and moral, of the average or composite teacher; y those of the average or composite student. The problem is not as simple as the formula would make it appear. Perhaps it would be well to drop the formula and use our reason and our common sense, which suggest to us at once that x and y are pretty much the same thing.

The teacher and the student are both human beings, though the one may have more of the experience and wisdom that come with age, and the other more of the intuition and enthusiasm that appertain to youth. The one *may* have, I say; for the "freshman" is not unknown — at Tech and elsewhere — marked by all the gravity and decorum of old age, nor the elderly professor — also at Tech and elsewhere — marked by the giddy exuberance of youth. Still, in every case, are they human beings. As St. Paul says: "We also are men of like passions with yourselves, who preach unto you in peace and earnestness"; though if you take the trouble to look up the quotation you will find that Paul's remark was occasioned by treatment not often accorded to the teacher.

So the student and the teacher are both men; I do not say men and brothers. I do not much believe in brotherly love for all the world. Love spread over such a broad surface would be pretty thin stuff. So when I hear a teacher talk of his affection for the five or ten thousand students who have sat under him, I can only answer, "nonsense." Even if he call his feeling friendship I should be apt to make the same reply. Friendship is so deep a feeling and so closely related to love that one can extend it to but few.

I do not much believe in brotherly love, but I do believe in courtesy to everyone; and back of courtesy, which implies tolerance, good will, which implies fair play. And there is no reason why mutual good will should not give us, teacher and student, good understanding and good fellowship.

The foundation of the relation between student and teacher should be good will and fair play. Both are working to the same end. The education of the younger generation in order that knowledge may increase and civilization progress; in order that the holy spirit of man may be helped onward toward perfection. And if teacher and student work together to that end both will learn and both will teach.

Both are working at the same job. Each is at an end of a two-man saw. Each in turn must push and pull in order to "saw wood." If there is not good will and fair play between them, if either hold back when he ought to push or pull, not only will the log be sawn but the blade of the saw will be bent. Even if they work with good will and fair play the saw blade may grow hot and balk in the groove. Then a strip of bacon rind run along the blade makes the going easy and smooth. So courtesy lubricated the wheels and tools of the educational "machine."

On the whole at the Institute I am sure that both teachers and students believe in and show each other good will, fair play and courtesy. Even the student who came into my office with his hat on and asked me if "Passano" was in, I am sure had all the good will in the world toward me, and — he did not do it a second time. And the teacher who wanted to give a student FF in . . . because he wore his suspenders twisted was courteous in the extreme, and — he left the Institute.

Why should there be ill will and unfairness between teacher and student? It would seem, as far as the records go, that in ancient times it was not so. Did the ill will arise from the envy of the monks when all teaching was in their hands; envy of the students' unrestricted freedom? or was its cause the resentment of the suffering student in those times when the birch-rod and the cane held sway? In any case the antagonism, if any of it remains, is now merely traditional, and the Institute is not a place of many or ancient traditions. Why not, if I may be allowed to paraphrase the song, "Let old traditions be forgot and never called to mind"?

Of course any student may know teachers he hates and teachers he despises — I will not put the case the other way around — but is it only *teachers* for whom he has these feelings? And when he has such feelings towards a man, is it not because the man has shown him ill will, unfairness or discourtesy? Indeed, in many if not in most cases, it is imagined unfairness, due to misunderstanding, that causes the dislike; and such misunderstanding can be best avoided by teacher and student knowing each other better.

Closer acquaintance and better knowledge can hardly be accomplished by the teacher. He can not seek out each individual student, but he can and does welcome the student's approach to himself. He is interested in young men; he likes to know what

THE TECHNOLOGY SERIES

Last year THE TECH ENGINEERING NEWS published a series of articles on the buildings, laboratories and business administration of the New Technology. This series met with such widespread approval among our readers that we are continuing the idea this year. Our new series will be of a slightly different character, dealing with the great personalities and the more human side of the Institute. As our space limits us to only a bare outline of the subject, it is hoped that the new series will serve as an inspiration to further reading along this line. The topics which the series will cover are as follows:

THE FOUNDERS OF THE INSTITUTE ..... *October*
Prof. H. W. Tyler, Head of the Department of Mathematics.

FRANCIS AMASA WALKER ..... *November*
J. P. Munroe, Secretary of the Corporation, M. I. T.

RICHARD COCKBURN MACLAURIN ..... *December*
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A HISTORY OF THE SOCIETY OF ARTS ..... *January*
Prof. H. M. Goodwin, Department of Physics.

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Prof. William Emerson, Head of the Department of Architecture.

RELATION OF INSTRUCTOR TO STUDENT AT TECHNOLOGY ..... *March*
Prof. L. M. Passano, Department of Mathematics.

A HISTORY OF THE DEAN'S OFFICE..... *April*
Author to be announced later.

GREAT GATHERINGS AT TECHNOLOGY..... *May*
Author to be announced later.

they are thinking and doing; from this he learns, as far as it is possible for him to know, what this world will be like when he is no more than the shadow of a shade, a memory in the minds and hearts of perhaps two or three. Moreover, as the teacher grows older his friends and acquaintances drop off one by one, and he has the hope that out of the multitude of young men he meets may be found a few whose friendships may replace the ones he has lost. Such friendships may also help the younger man. One of the best and truest friends I ever had was fifty years old when I was but ten or twelve, and there is no more beautiful picture of human friendship than that of the old lama and his beloved disciple Kim.

The lack of closer acquaintance between teacher and student is, it seems to me, one of the Institute's greatest faults. The blame can not be laid upon any one thing. The large number of students, the environment, the widely scattered homes of the teachers and the pressure of work all must share the blame. But the blame must be borne in part by the students themselves in that they do not seek to know their teachers outside of the classroom. Perhaps they do not wish to know us. I can understand that. Perhaps they do not wish to know too much about themselves. I can understand that, too. But indeed both teacher and student lose much by such aloofness.

It has been said I think — at least it is true — that really to know a man you must cruise with him in a small yacht. Well we can not all go cruising on the Basin but if the student now and then would smoke a pipe or a cigarette with the teacher in his office — not in the corridors — and chat with him forgetting their official relation, both could make some approach to knowing each other unofficially. If the student does not enjoy his first call he need not make a second, and on the other hand he may rest assured that the teacher will not let him interfere with more pressing affairs. Nor need the Dean's office fear that the Institute's work will degenerate into a sort of old-fashioned New Year's Day when everybody called on everybody else. That custom needed "stimulation" and, rumor to the contrary notwithstanding, I believe the offices at Tech are entirely free of "stimulation."

There is a description of one such call, an unintentional one, a call unsolicited and unsought, in the greatest book in the world. You will remember that Alice, in her interview with "Professor" Caterpillar, repeats at his command the old poem, "You Are Old, Father William;" but, being already rattled by his quizzing, says it "wrong from beginning to end," as he tells her decidedly. Moreover, made forgetful by nervousness no doubt, she omitted two stanzas which in consequence have appeared in no edition of the wonderful book of her adventures that I have seen; stanzas of such force and beauty that I quote them here: "You are old," said the youth; "there you sit in your nook, with expression as blank as a rabbit's, never casting so much as a glance at a book. What gave you such singular habits?" " 'In my youth,' said his father, 'I studied at school: with my teacher I warred to the knife; and the hatred I felt for that bigoted fool has lasted the rest of my fool life'."

Father William may have been justified in his youthful hatred, but from what I know of his record since I have my doubts. And think in what a deplorable condition his hatred and warfare to the knife left him in his old age! Less warfare and more tolerance would have been much better for him and so much easier for his nameless teacher.

You will observe — of course you have read the book — not only that Alice treated "Professor" Caterpillar with respectful courtesy and obedience, but also that she was a "student" who possessed two qualities of inestimable value: a sense of humor, and, if I may be allowed so to express it, a sense of good humor. And I would particularly call your attention to the fact that in the end by obedience she got exactly the information she wanted from the caterpillar. So if Professor A tells you in caterpillarian tones to hand in seven and one-half problems, on pink paper, ruled with purple ink, at exactly twenty-four minutes past eleven, on Friday the thirteenth, *do it*. He *may* have a reason for the assignment. You can have any thoughts you please about the matter, and can smile — courteously, after your back is turned — because it is humorous and you are good humored.

Thus if teacher and student will try to know each other; if, in their dealings with each other, they will have tolerance, humor, and good humor; if between them is good will, fair play, and courtesy; then the relation between student and teacher at Tech will become — very much what they actually are at Tech; not perfect, indeed, but at least securely based on the cardinal virtues of educational as of all friendly human intercourse.

I am not sure, but I think we have found our x and y, and have solved our problem without a formula. I need hardly remark in closing that all I have said applies only to students who come to the Institute to learn. For those who come to avoid learning, as the poet says "There is no place like home."

America's Supremacy in the Dye Industry. The supremacy of the United States over Germany in the dye industry is borne out by the fact that we now produce 93.5 per cent of the dyes actually used in this country. Although it is still necessary for us to import the remainder from Germany and Switzerland, which represents only the latest developments of the dye industry in these two countries, there is every indication that eventually the United States will supply most of the dyes to the world.

Before the war Germany had done more scientific research along this line than any other country, and was actually the home of the dye industry. When the war shut off the foreign dyes we were compelled to fall back upon our own resources with the result that now not seven per cent of the dyes used are of foreign manufacture. — *Journal of the Franklin Institute.*

Oil Fuel for Domestic Heating. The burning of fuel oil for domestic use has been on the decline on the Pacific Coast. Most of the manufacturers have discontinued making burners for the use of oil on a small scale believing that they are too expensive for the average home owner to install. While fuel oil is obtainable on the Coast, it is difficult to get sufficient quantities in the interior of the states, it often being necessary to contract for several years' supply in order to get tank wagon delivery. Rotary burners of small enough capacity for home use have not been satisfactory, and the average man knows little or nothing of the mechanics of the installation, experiencing considerable difficulty in the operation of it.

France Plans Tidewater Power Plant. The French Parliament has passed a law approving a project that will call for the erection of a power plant utilizing tidal energy. The construction will involve a dam of 150 meters and four groups of turbines operating on both the inflow and the outflow of the tide, their power ranging from 75 to 1,200 h. p. when running at various speeds. The use of the tides will be carried on with that of the water power drawn from a fresh-water stream in the neighborhood, thus making it possible to regularize the total power produced. Fresh water and the tide plants combined will furnish a minimum of 1,600 h. p. and a maximum of 3,200 h. p. The equipment will furnish power equal to that produced by 16,500 tons of coal per year, according to *Commerce Reports*.

COPPER IN MODERN STEELS

I. HARDNESS

By GEORGE J. FERTIG
Graduate Student, Massachusetts Institute of Technology

ENGINEERS, designers and machinists live in a world of metals in which iron and steel play the greatest part. They use metals as their servants and have an intimate knowledge of the virtues and vices of these materials, appreciating their various qualities as a man appreciates the qualities of his human associates.

A skilled executive will cause his ideas and his schemes to be carried

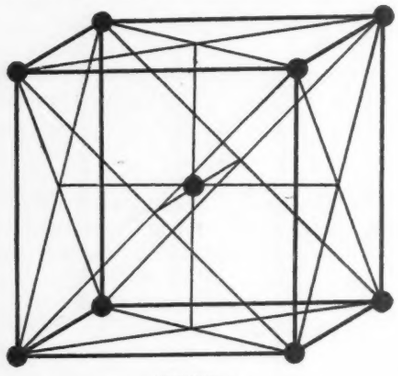


FIGURE 1
The Iron Form. Body Centered

to success by men whose birth, education and early training are sometimes of small importance to him. Just so, the man who daily finds himself requiring the service of metals and alloys is sometimes ignorant of the attractive features which characterize them and of the interesting phenomena which make metals useful to him. Surprisingly few are those who can relate the story of steel and fewer still are those who are familiar with the function of copper when it is intimately allied with steel.

In the early days of steel manufacture in the United States, iron ores were used which were practically free from copper. The opinion was formed generally that a steel made from copper bearing ore and thereby containing copper itself was inferior to a copper free steel. Sulfur and phosphorus were known to be injurious materials in steel and metallurgists in the past were prone to view copper with the same skepticism as they accorded sulfur and phosphorus. The customary processes of blast furnace smelting and open hearth treatment did not remove the copper present in the original ore. To make a separation and thus to manufacture a steel comparatively free from copper would prove expensive. Large quantities of iron ores in this country were beginning to run higher in copper and foreign ores themselves were far from free from it. Not only did the metal have to be put into rails and other structural shapes but large quantities had to be worked in the puddling furnace to make wrought iron and in foundries to make miscellaneous cast steels. To steel makers and steel users alike it was important that the skepticisms regarding the influence of copper in steel be supplanted by actual tests and scientific investigations and that any alterations due to its presence be determined.

The presence of copper in steel gives rise to a number of interesting phenomena. Because hardness is a physical property by which metals are often judged it has been elected to present principally the effect of copper on the hardness of steels.

When carbon is added to molten iron it is found that a certain small amount of it dissolves in the iron, forming upon cooling an alloy much harder than pure iron. If the amount of carbon in the cooled mass is more than 2.5% the result is cast iron, if less than this amount the product is a steel. Steel, then, is a combination of pure metallic iron with small amounts of carbon. For the present a consideration of such elements as manganese, phosphorus, sulfur and silicon, which are present in commercial steels, will be postponed.

This article is specially prepared for THE TECH ENGINEERING NEWS from actual data obtained by Mr. Fertig. Part I, printed in this issue, gives some very interesting details concerning the hardness properties of copper steels. Part II, which will be published in our April issue, deals with the corrosion features of these steels.

Hardness is the resistance to permanent deformation. Since steel differs from iron by the amount of carbon present, evidently the carbon has served to make the mass more rigid and less distortable. When pure molten iron cools to room temperature, the microscope shows that it forms in minute cubes of exceptionally small dimensions. In the pure metal the cubes are found face to face, all oriented in the same direction within the same grains. X-ray analysis reveals that each of these individual cubes of iron at room temperature is made up of many smaller cubical formations of iron atoms arranged as body centered cubes. (Fig. 1.) Each grain of the metal known as iron is constituted by rows upon rows of these cubes placed face to face to each other extending in three directions. The cubes meet each other in planes which extend throughout the grains and when a grain of iron is distorted or torn apart rupture is said to occur at these planes of junction. Deformation is the slip of planes of atoms over each other. (Fig. 2.) When two different metals alloy it is believed that the atoms of the metal present in the lesser amount replace an equal number of the atoms of the metal present in the larger amount. Such replacement invariably provokes a change in the dimensions of the cube into which the foreign atom enters and therefore breaks the symmetry of the plane surfaces between atoms. Slip now is more difficult and the alloy is said to be harder than the pure metals of which it is made. (Fig. 3.) In steel, carbon plays the part of a foreign atom in its alloying with iron and causes irregularity in the slip planes. Slipping is hindered thereby and the steel is found to be harder than the pure iron.

Copper is shown by microscope and X-ray spectrometer alike to solidify from its molten state in cubical forms of a little larger size than those of iron. Its arrangement of atoms is

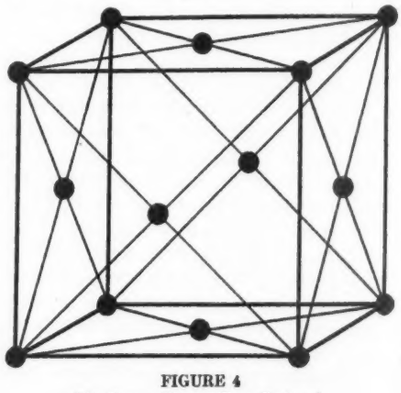


FIGURE 4
The Copper Form. Face Centered

slightly different from the disposition of atoms in the pure iron cube. The arrangement is that of the face centered cube. (Fig. 4.) Pure iron and pure copper alloy in all proportions — each of the resulting alloys being harder than the respective pure metals themselves. When carbon is present, however, the amount of copper which will alloy with the iron is very limited. In cases where the carbon content is high, as little as four or five per cent

of the copper will dissolve in the iron. The excess copper separates out as metallic copper and appears either in globular form within the grains or is rejected to the grain boundaries where it serves to impart a reddish tinge to a fracture.

It follows from these theoretical considerations that copper would serve as an agent for increased hardness. A steel of definite carbon composition with copper, therefore, would be

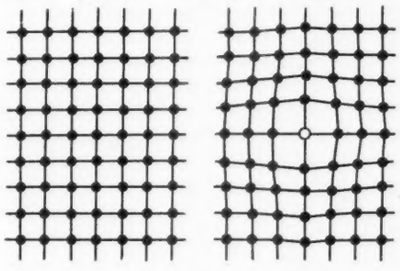


FIGURE 2
Slip Planes in Pure Metals and in Alloys

harder than a similarly treated non-copper steel of like carbon content, provided the copper content be held within certain limits.

But a theoretical consideration of the relation between copper and hardness would be of limited value unless it be accompanied by actual physical tests or by reflections from industry itself upon the behavior of copper bearing steels in service. Industrial records vary somewhat in their bases for comparison, however, so that uniform scientific tests prove more practical and accurate.

The physical properties of metals depend upon a large number of factors. Hardness itself is a function of many variables, especially in steel. It is influenced by such conditions as composition, heat treatment and mechanical treatment. Under various circumstances all of these factors combine to give a piece of steel a definite resistance to being torn apart or distorted. It is a rule that the resistance of a metal to being pulled apart under tension is a measure of its hardness. Hence, by comparing the forces necessary to pull apart equally sized bars of similarly treated copper bearing and copper free steels, a relation between copper and hardness might be obtained. Such a relation has been determined, first, in the case of steels which contain copper only, and later for alloy steels containing copper and nickel, and copper, nickel and chromium, respectively. (Fig. 5.) In each of these instances the amount of carbon, manganese, phosphorus, sulfur and silicon were regulated so as to remain substantially constant. The heat treatment and mechanical treatment was controlled so as to vary but slightly. The tests were taken from air cooled bars. The results are evident that copper, whether found in simple carbon steel or in certain alloy steels, improves the hardness, since the latter is measured in this case by the tensile strength.

The hardening effect of copper upon steel in which it is present has been explained, first, in the light of modern theories of hardness and, secondly, has been verified by experimental tension tests. But to close the review of the question without looking at the views of the people who make and who utilize steels in which copper is a component would be to neglect a large portion of the value of the foregoing explanation. The tests which industry require of a material are many times versatile and often times cannot be analyzed and divided into simple factors. The requirements which are made upon copper steels cannot always be separated into recognizable elementary characteristics. Undoubtedly, hardness is a function of many variable factors, but often the successful application of a steel to an industrial use has depended upon a property which can frequently be distinguished as that complicated function which has been called hardness.

The metallurgist has been the first to notice the manner in which a copper steel differed from a simple steel. His records show that in the ladle copper mixes well with the molten steel and remains evenly distributed throughout the mass during the process of pouring into ingot molds and through final solidification. Had this not uniform distribution persisted, the finished steel rails or bars would have had undesirable irregularities in their properties. When the ingots are reheated for the purpose of rolling them into commercial shapes it is found that for low carbon steels the copper cannot be more

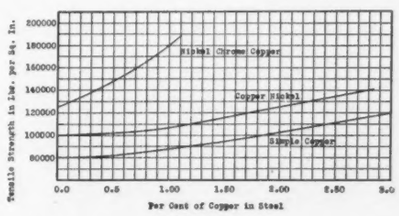


FIGURE 5
Effects of Copper on the Tensile Strength of Steels

than five or six per cent, else the steel will overheat and later crack and flay as it passes through the rolls. For medium carbon steels a limit of two per cent of copper has been found as a maximum. When these ranges of composition are complied with, copper steels are found to be more easily deformable without cracking than non-copper steels. Operations such as deep flanging and the rolling of light weight tubing are more successfully performed on the latter type of steel. Bessemer steels containing copper in accordance with the above prescriptions have been subjected to sudden and extreme reduction in the rolling process with noticeably good results. Open hearth copper steel has behaved well under the same hammer as well as in the rolling process whether the finished product has been either plates or more condensed shapes. Copper,

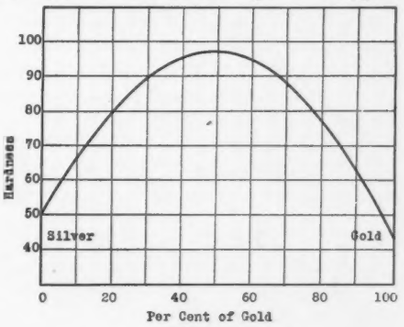


FIGURE 3
Hardness of Silver Gold Alloys

in general, has been found to increase ductility in the heated steel without sacrificing hardness as a property of the finished product. It has served in imparting greater elasticity and workability than would have been possible in steels in which it was absent or present in very insignificant amounts. From the viewpoint of the makers of steel the presence of limited amounts of copper has added noticeable advantages.

To those who utilize finished products is given the privilege of final decision as to the success or failure of a product in use. The successful metallurgist is one who separates the requirements for the suitable application of a metal to certain uses into as near elementary factors as possible and who knowingly attempts to develop a metal which will fulfill each of these elementary factors. In such analyses as he is called upon to make, the factor of hardness is invariably encountered and although in some cases it is difficult to isolate as a separate requirement it always enters as an important consideration. When a steel has met with favorable industrial application it is undeniable that it has satisfied the essential of hardness. Whenever a copper steel has been found to answer the needs of a certain use it is understood that among other things its hardness has been equal to the demands of the occasion. Plant records are wealthy in interesting incidences of the successful adaptation of copper bearing steels to a wide range of uses. Light armor plate bearing copper has found favorable adaptation on battleships. Gun linings have been

(Continued on page 378)

THE JAPANESE EARTHQUAKE

By J. P. TRAPHAGEN
Orient Division, George A. Fuller Company, New York

This article is an abstract from a letter which was written by Mr. Traphagen to the George A. Fuller Company of New York. Mr. Traphagen, who is connected with the Orient Division of the company, was in Dairen at the time of the Japanese earthquake. As soon as he received reports of the disaster he set out for Tokyo and Yokohama. His letter portrays vividly some of the conditions he found in these cities and also gives a good idea of the remarkable stability of the buildings constructed by American engineers. *Editor.*

WIRELESS reports regarding the Tokyo earthquake were received in Dairen about noon on September 2 and, due to the alarming information contained in these incomplete reports, I arranged to leave for Tokyo at once, and fortunately was permitted to join the United States destroyer *Whipple* which was one of the United States squadron on visit to Dairen and which had at once been ordered to proceed to Tokyo to render all assistance possible to the refugees.

The squadron reached Yokohama on Wednesday, September 5, the *Whipple* having instructions to proceed at once to Tokyo and get in touch with the United States Ambassador. Arriving at Tokyo about seven p.m. we went ashore, going direct to the Imperial Hotel where the American Ambassador had secured temporary offices after the embassy had been destroyed by fire.

To reach the shore from where the *Whipple* had anchored was a distance of some two miles, and in this distance our launches passed probably more than two hundred bodies floating on the water, we later being informed that thousands of Japanese during the fire had thrown themselves in the canals to escape the intense heat and had been drowned, these bodies floating all over Tokyo Bay and even as far south as Yokohama harbor.

On landing we found Tokyo in entire darkness excepting for small fires still smouldering in every direction, and from the landing place to the hotel, a distance of some two miles, we had to walk through what had once been business streets, but now was completely filled up with the wreckage of collapsed buildings, the remains of tram cars, automobiles, and nothing but desolation on every side.

The American Embassy officials were doing everything possible to assist the refugees, many of whom had been camping in the parks, streets and hotel grounds for four days with but little clothing and hardly any food. The officers of the *Whipple* at once made arrangements for taking these refugees to Yokohama on the following day for transhipment to Kobe, and they certainly rendered splendid service, assisting all foreigners that required help, giving food, medicines and clothing from the limited stores they had, the *Whipple* making several trips to Yokohama, taking all foreigners irrespective of nationality. The Japanese refugees were being cared for by Japanese boats.

It is well at this time to mention that our American destroyers and warships were the first to arrive at the scene of disaster, although coming a longer distance than the relief boats of other nations. The American ships had been calling at Dairen, some thirteen hundred miles from Yokohama, arriving here sixty-six hours after receiving sailing orders, which was a record run as considerable of this trip had to be made through dangerous straits off the coast of Korea. In addition to this fleet, additional American warships had been ordered by our Navy Department from Manila and Tsingtao with all kinds of emergency medical supplies, foodstuff and clothing.

The British ships coming a shorter distance reached Yokohama one day later also rendering very valuable aid. Several Japanese destroyers from Port Arthur arrived two days after our arrival. Too much praise cannot be given to our American sailors for the splendid service rendered by them under most trying circumstances, due to the red tape obstructions of Japanese officials who strongly opposed the entrance of foreign ships in Tokyo Bay which was a forbidden zone to foreign shipping. The destroyer *Whipple* was the first foreign warship to ever enter these waters, and did so without securing Japanese consent, but to meet this emergency they were fully justified in proceeding without waiting for Japanese approval. Later on our Ambassador, after much argument, secured proper authorization permitting foreign ships to enter this forbidden zone so that all foreigners could be given necessary assistance.

Due to the fact that Friday, August 31 was a holiday a large number of the foreign residents of both Tokyo and Yokohama had left for the mountain resorts some distance from Tokyo, expecting to return on September 3, therefore a large proportion of the foreign residents of this section were outside of the earthquake zone, escaping injury, but practically all losing their homes by either earthquake or fire.

In Tokyo we found the parks and streets crowded with Japanese home-

THE MARUNOUCHI BUILDING INTACT EXCEPT FOR PORTIONS OF THE OUTER TILING

less refugees, to the number estimated at over one million, as many more having left on foot for interior points, which fact somewhat relieved the situation. Conditions were becoming serious, as only a limited quantity of food was available and drinking water not obtainable. The authorities in their limited way were, however, busy doing all that was possible, and clothing, rice and other foodstuffs were beginning to arrive.

We found that practically the entire business section of Tokyo was

THE MODERN JAPANESE OIL BUILDING STOOD THE TEST WELL

destroyed, only a part of the residential section escaping the flames.

The city was laid out in wards, each ward covering a section approximately from one to two miles square, the principle business wards being as follows:

Kyobashi	100% Destroyed
Nihonbashi	100% Destroyed
Asakusa	95% Destroyed
Honjo	95% Destroyed
Shitaya	85% Destroyed
Kanda	100% Destroyed
Marunouchi	20% Destroyed

The greater majority of the buildings included in these sections, excepting in Marunouchi, were of wood, brick, or concrete construction, one to four stories high, the larger number being built of wood frame, covered with heavy tile roofing. The first shock caused most of these buildings to collapse giving the occupants no possible chance of escaping; flames immediately starting in every direction, simply cremating people by thousands, as water mains were all broken and the fire department useless.

In Nihonbashi section were located several large retail department stores and these were all destroyed by flames, leaving nothing but the skeleton frames standing.

The remaining wards of Tokyo were mostly residential, being badly damaged by earthquake, but fortunately escaping total destruction from fire, or the loss of life would have been much greater.

The Marunouchi ward was more fortunate than the others, receiving less damage, probably due to the fact that the type of buildings erected in this section were chiefly steel frame, granite or reinforced concrete construction, however a number of the larger buildings were damaged beyond repair, chiefly due to inferior materials being used in their construction. I cite as an example, the Palace Hotel, a building six stories high with roof garden completed only last December and built of Japanese fabricated steel frame, brick and concrete, the steel being so badly twisted that the building will have to be torn down. Another example was the Naigai Building adjoining the N. Y. K. Building, built of reinforced concrete, and which collapsed killing more than one hundred and thirty occupants. The wreck of this building was due entirely to faulty construction. Fortunately owing to the wind having shifted, a majority of the other buildings in this section escaped the flames or the destruction would have been much greater.

Statistics just published are giving the number of buildings destroyed by earthquake and fire as compiled by the Government as follows:

Residences	142,993
Assembly Halls	94
Shrines and Temples	1,936
Factories	4,768
Theatres	193
Government Buildings	964
Schools and Libraries	980
Banks and Business Offices	8,025
Warehouses	12,343

Later on I had an opportunity to visit Yokohama and found that the entire business section of the city located in what was known as the settlement was absolutely wiped out. The centre of the earthquake had apparently been here, and was told that practically every building collapsed from the first shock, burying thousands in the debris, the flames finishing whatever was left from the earthquake shocks. Only the walls of three or four concrete buildings were left standing, being the Russo-Asiatic Bank, Yokohama Specie Bank, and the new telephone exchange. Practically every wharf and warehouse collapsed, destroying the city's entire shipping facilities. The foreign residential section, known as the "Bluff," where many beautiful residences and hotels had been located, was in entire ruins, and Yokohama, once a beautiful city, was now nothing but a scene of misery and desolation.

The following will give my observations regarding the damage to buildings erected by the Fuller Company in Tokyo which was made under the most difficult conditions as all streets were crowded with refugees standing in bread lines and all buildings entirely closed up so that I could not ascertain whether the interiors had been damaged to any extent, but from outside views assume that there was little or no damage sustained to any of the interior work. It must, of course, be understood that a close

DAMAGE TO THE YUSEN BUILDING WAS CONFINED TO BRICKWORK AND FACING

technical examination by an engineer may disclose a more serious condition but on the surface feel quite confident that the buildings can easily be reconditioned within a few months, providing materials and labor can be secured.

Marunouchi Building. Many cracks in brick and concrete filling between the steel columns on the second and third floors. Outside tiling had been badly buckled in many places and fallen off, but this tiling was simply ornamental and added nothing to the strength of building. Steel framework appeared to be absolutely intact without any shifting of position. No window glass was broken.

N. Y. K. Building. Steel frame absolutely intact with no shift, considerable damage to brick walls and terra cotta between the steel columns on the second and third floors, most of which occurred on the corners, also some of the exterior terra cotta was badly cracked on upper floors. The interior walls on first floor showed no cracks nor was any window glass broken.

Japan Oil Building. Steel frame intact with no shifting, some damage on second and third floors to the

(*Continued on page 376*)

THE MOST PROBABLE WORLD

By BASSETT JONES, '99
Consulting Engineer, Mayer, Strong & Jones, New York

"LUCK" is a popular name for the result of unknown or unrecognized causes. A man may be "lucky" or "unlucky" in drilling for oil or in his investment in oil operations. He would not be so "unlucky" if he knew before he started operations that the chances were 1 to 100 against him. If a man knows it is practically a certainty that he will strike oil at least once in a hundred trials at a cost, let us say, of $40,000 a trial, then he will be no fool if, having $4,000,000 to risk, he goes into the game. At these odds, he will be a fool directly in proportion as he can finance less than one hundred failures.

Luck they say, is blind. Even though often very near-sighted, the eyes of chance are open.

This is why the "lucky" rich man generally wins in the high game of finance, and, with equal generality, the "unlucky" poor man joins the herd of "wool" producers. And this may be true even if we consider that both have equal sources of information. Generally the sources of information in "Wall Street," like the location of oil pools in the known sand bed, are of unknown accuracy. But the "chances" are in favor of the rich man because he can stand the gaff of a sufficient number of failures to make it certain that he will win once.

The operator in "sand" and the operator in stocks are like Clerk-Maxwell's theoretical experimenters who never see the mechanism they set in motion. But, unlike the experimenters, the operators do not take the time, or lack the analytical ability,

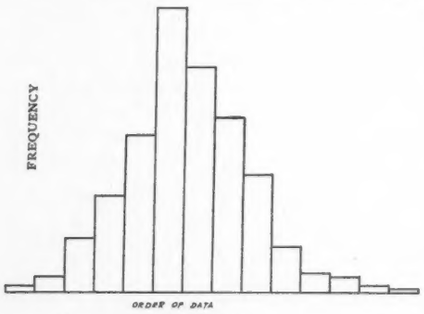


FIGURE 1
Histogram

to work out a theory of the connections between the strings they pull and the results produced in the remaining visible parts of the mechanism. If the theory indicates that when a given string is pulled a certain result follows, and if the experimental result *always* coincides with the theoretical result, chance is converted into certainty. But since "always" means that the rule holds true in every possible case, past, present and future, the most that can be truthfully said is that a marked probability of a given result following a given operation exists.

Even when an exact theory cannot be, or has not been, worked out, a rougher determination of the average behavior of the mechanism may be had, so that the average result of a number of distributed experiments either simultaneous or successive, may be pre-established. Indeed this is the most generally useful method and as will be shown later is the form that most theory takes. It is the method of statistics.

> *If the World is so constituted of an ordered but discreet collection of events and discontinuities, it is no wonder that, taking life to be a toboggan slide, we are badly bumped when too late we find the world to be a very uneven flight of steps, with several jumps added that make the going fit only for expert skiers.*

A friend of the writer's who had spent much time studying the stock market and had been successful by the use of distributed small investments, afterward blindfolded himself and made an equal number of random selections by pricking a market report with a pin. If he had made his investments by the random method he would have made more money than he actually made by his carefully selected investments. As such things go, this is not an exceptional result. The basic reason for the investor's success was the fact that he bought on an average low market, sold out on an average high market and put his money in the savings bank, to wait for the next average low market. On this basis practically any reasonably widely distributed individual investment as a whole, will make money.

The analysis of the general phenomena of chance leads to the theory of probabilities and it is found that the behavior of most, if not all, natural phenomena, not only those associated with gambling, but with physics as well, fall within its scope. By it, even those results of experiment that seem to fall within the realm of definite uncertainty, are reduced to order. Only ordered phenomena, no matter how complicated their order may be, are amenable to logical discussion and to mathematical treatment. In other words, we can reason only about ordered phenomena.

Any one who plays poker on a right system of hand rating based on probabilities in the end, must win, even though it be but little, and the resulting game be of little real interest to himself or to his fellow players.

Nothing is so apparently uncertain in this world as the span of a man's life, yet billions of dollars are invested successfully in a method of betting on just such seeming uncertainties.

Without going into further details, or into a more philosophical discourse, aimed to prove that the innocent bystander, as a member of society, must share the blame for the failure of another individual, or of society as a whole, to properly analyse past performance and so deduce and act upon the rules for present and future conduct, may we now write down that "bad luck" is invariably due either to ignorance or to carelessness? Contrariwise, "good luck" is the intelligent determination of "the best bet" backed by sufficient courage to place the money. This applies alike to personal behavior, to business, to horse racing and to scientific research.

The rule of probabilities assumes a certain discreteness of events. It implies a degree of discontinuity in any group or sequence of the phenomena with which it deals, after the manner that the faces of a die are different, one from another; as the terms in a mathematical series are different, one from another; as the people in any group differ in tallness, one from another. It denies the possibility of smoothness or infinitely fine gradations in such differences between the elements of group or sequence, in the sense that the older mathematics sought to define continuity and infinity. In the theory of probabilities as applied to statistics, the order and frequency with which the data or events relating to growth, change, or differences occur, are illustrated by a *histogram* of the general type shown in Fig. 1. That the steps in this figure and the corresponding class-intervals in the

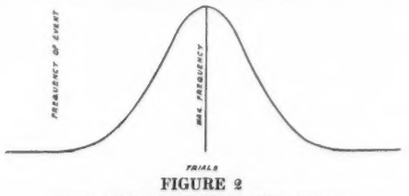


FIGURE 2
THE NORMAL FREQUENCY CURVE

data may be exceedingly fine is beside the point. They can never be so fine that they cease to be steps to an eye or to an instrument of sufficient resolving power to discern them. The assumption that such a change is continuous must lead to error if the analysis be fine enough.

Such an assumption would be equivalent to accepting the possibility of distinguishing between the facets of a sphere, or to playing craps with spherical dice. The arbitrary reduction of the discrete intervals between actual events to a continuity results in a conclusion that does not correspond with any known real order or sequence of phenomena. The flow of a river turns out to be the average motion of a group of discrete water molecules. The electric current is found to be a flow of discrete electrons. The assumption of continuity leads to Zeno's paradoxes. It leads to such difficulties as the distinction between a sphere and a polyhedron as the number of facets is indefinitely increased. That the "limit" of the polyhedron, as the number of faces is increased is a sphere, is a reasonable assumption only if it be never necessary to distinguish that the difference, however small it may be, exists.

It is obvious that every real physical polyhedron must be different from every real physical sphere, and that this difference must be a measurable difference. Otherwise it is not a physical difference, and so, in the physical sense, is not real. There is no "real" point in space and time where we can say "this polyhedron has so increased the number of its faces that it has ceased to be a polyhedron and is now a sphere." Therefore any method of analysis that is founded on such physical impossibilities eventually must lead to error. The experimenters have evolved a theory of connection between the strings that is not "always" true.

As will be pointed out below, it is the necessity of making this distinction between continuity and discreteness that has led to recent failure in the "classical" methods of analysis. Here again, as was remarked in the writer's article "Mathematics", (TECH ENGINEERING NEWS, Vol. IV, Number 5, p. 161, November, 1923) the habits of thought engendered by the continued uncritical acceptance of abstract generalizations, have led to a confusion of ideas.

It seems strange that physical theory has permitted itself to arrive at this *impasse*, when the theory is itself fundamentally and necessarily of a statistical nature.

The Dynamic Theory of Gases is a method of determining the most probable arrangement and grouping as to number per unit volume and as to velocities of the molecules whose motion is assumed as random. If the motion of the molecules were as random as the assumptions made, then "real" gases would be of the expected character. That real gases differ from the expectation is *prima facie* evidence that the molecular motions are not altogether random but are constrained in certain undetermined ways. It is probable that,

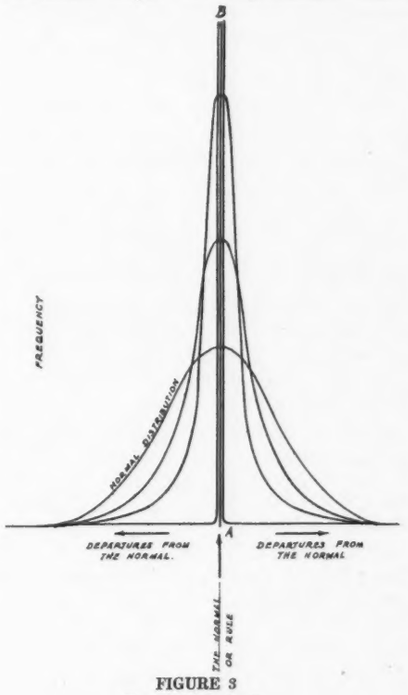


FIGURE 3
Types of Distribution

in the nature of things, observations made on actual gases, being relatively coarse-grained and rough, give average results in which the most probable result is merely the specific result occurring with the greatest frequency. In his "Dynamical Theory of Gases," Jeans quotes Clerk-Maxwell as stating that, according to the laws of thermo-dynamics, it is only extremely probable, but not certain, that if a kettle of water be put on the fire it will boil and not freeze.

Again, Legrange's generalized equations of motion are statistical statements of the most probable relations between the coördinates of point-masses whose unconstrained motion is quite random. The modern theory of mechanics as developed by Maxwell and Gibbs is purely statistical in its nature.

Recall the Laplace attempt to show that, since the arrangement of the celestial universe cannot be deduced completely from random motions, its arrangement indicates the existence of a primitive restrictive cause. Modern astronomers reverse this process and attempt to deduce from the observed relations the most probable cause of these relations.

It is probable that the whole of physical theory can be summed in the Einsteinian statement, that "*the present state of the world is that which is statistically the most probable.*" In other, and less elegant terms, the world is a good bet, and this conclusion is also the net outcome of modern philosophical argument. "This is the best of possible worlds," says Josiah Royce, so that altogether, there is very little room for the pessimist in this four-dimensional universe of ours. As a matter of fact, the pessimist usually turns out to be the man who went drilling oil with not enough money in his pocket to finance his failures. Yet, no matter how great are the odds against him, the player does draw a royal straight flush; the first drill does strike oil, and we all rush in to sink our savings in the quicksand.

Thus every kind of human activity is based on "chance". The predetermination of the result depends on the accuracy with which the probability of the occurrence or non-occurrence of any event can be established. Our failures result from our ignorance of such probabilities, most of which are weighted for or against us. That is, the events are rarely, if ever, entirely random. We are playing with loaded dice. And we devise all kinds of rules, Newton's Laws of Motion for instance, which are presumed to tell us how the loading occurs. But we are disposed to forget that such laws of the game are only probably, not necessarily, of a piece with nature. The disposition of the planets in space is not completely in accordance with any theory of celestial mechanics. Neither is it entirely random.

To illustrate the meaning of this statement, consider the case of events that so far as our experience and powers of discrimination go, may be taken as entirely random. Such are the throwing of dice, the distribution of shots in a gun pattern, the probable errors in measurements about which many of you have learned, or are learning, under the subject of "least squares," and a vast number of other data that fall under the scope of statistics. The frequency with which any given number of such events occur simultaneously, or the frequency with which any specific event occurs in a given number of trials may be illustrated by the normal "ideal" curve of distribution shown in Fig. 2. Depending on the initial data given, the maximum ordinate of this curve gives either the events which will most probably occur simultaneously, or the event which will most

(*Continued on page 382*)

PRINCIPLES OF FIRE PROTECTION

By ROBERT S. NEWELL
The New York Underwriters Agency, New York

RECENTLY completed records of The National Board of Fire Underwriters definitely establish the fire loss in the United States for the year 1921 as $396,324,810. With the customary addition of twenty-five per cent to cover losses unreported and uninsured the total becomes $495,406,012 which represents a burning rate of sixteen dollars a second! That is just the property loss. Other contingent losses would, no doubt, raise the total to a billion.

From two hundred fifty thousand to three hundred thousand fires are reported each year. All were incipient at the start and practically all by adequate protection could have been controlled and so prevented from causing but a nominal amount of damage.

While a building itself cannot cause fire it can contribute largely to the spread of fire once it has started. It is well, then, before equipping a building with fire extinguishing devices, to consider what structural principles should be observed to reduce the rapidity and extent of fire spread. The essential faults to correct in existing buildings and avoid in new construction, so far as it is practicable with the nature of occupancy, are:

(Wherever the word "approved" is used it refers to devices which have been tested and approved by the Underwriters' Laboratories, Inc.)

1. Unprotected Vertical Openings, such as elevator shafts, stair shafts, light wells, dumb waiter shafts and belt holes.

2. Concealed Spaces which are formed by sheathing on walls, ceilings and partitions and all other horizontal or vertical flues created by sheathing.

3. Unnecessary Combustible Construction such as shelves, cupboards, partitions and interior finish. These should be removed or replaced by others of incombustible nature.

4. Wooden Cornices, unnecessary combustible roof structures, adjoining platforms and sheds.

5. Unprotected plain glass skylights.

6. Combustible roof covering.

7. Unprotected openings through division walls of fire-resistive construction.

8. Unprotected Exterior Wall Openings.

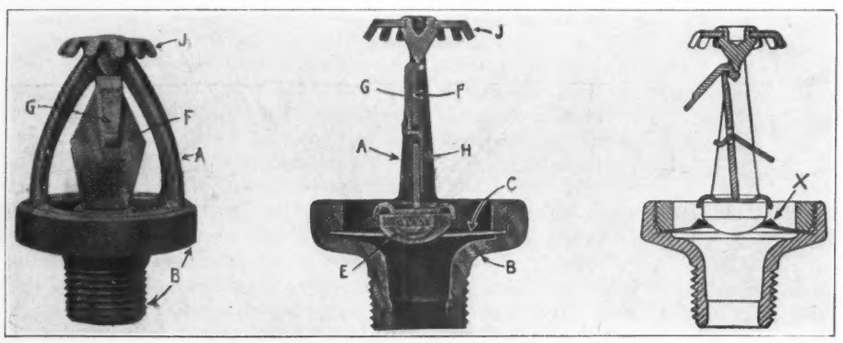
Vertical Openings

The existing draft caused by the unenclosed vertical opening intensifies the fire on the floor where it has started and the fire and smoke following the draft conditions are rapidly conducted upward through the building. Generally speaking the opening should be enclosed with material having fire-resistive power equal to the floors. The enclosures should be of brick, concrete, terra cotta or gypsum blocks, cement plaster on expanded metal, plank or double matched boards. In the ordinary joisted type of construction, which is more common than any other, the stairways should have a separate enclosure for each flight not less than one and one-half inches thick; double boarding is preferable to single, as it is not so liable to warp and open up at the seams. Doors in enclosures to have fire-resisting power equal to the enclosures and hung on heavy wrought iron hinges, latches and catches to be attached by bolts. Doors to be kept closed and latched when not in use. It is preferable to attach a stout spiral spring to all doors to keep them closed automatically. All hallways extending up through a building, should be shut off from the rest of the building at each floor by enclosures and doors equal to floor thickness.

Elevator shafts to be enclosed at each floor by double matched boards one and one-half inches thick and self closing doors provided, the same thickness as enclosure. Occasionally owners prefer automatic trap doors for elevator openings rather than enclosures. These are generally operated by the elevator in its rise and descent. Stair and elevator openings in buildings of Fire Proof or Slow Burning (Mill) Construction, not cut off in fire resistive shafts, are a violation of a most prominent principle of such construction. When they exist, however, they should be enclosed by fireproof material, varying from eight inches to sixteen inches in thickness and all door openings provided with approved self-closing fire doors. Light wells when they cannot be floored over should have fire-resisting walls and wired glass windows.

2. *Chemical Extinguishers.* There are many and various types of extinguishers on the market and only those which have been tested and "approved" should be purchased. Poorly designed and constructed extinguishers have been known to have burst and cause loss of life. Portable extinguishers vary in size from one quart to the thirty-three gallon type on wheels. The most widely used extinguisher is the two and one-half-gallon soda and acid type. The great value of this form of extinguisher is that it gives a good stream of water under high pressure for about a minute. The stream reaches thirty feet from the operator and can be readily used on ceilings and hollow walls, etc., where pails would be hard to use. The one quart carbon tetrachloride extinguisher is extensively used and is valuable on fires in volatile liquids such as are encountered in automobiles, motor boats, etc. The latest make extinguisher is the foam type. This extinguisher is made in various sizes and has proven to be effective on any fire, remarkably so on oil fires. This make throws a good stream of a foam-like substance which covers any surface it touches with a blanket of tenacious carbonic acid gas bubbles which later dry up and can be readily brushed away. Dry powder tubes and glass bottle hand grenades have no place in fire protection and should be consigned to the scrap heap. There is a type of extinguisher for each particular case but only "approved" makes should be used and in sufficient numbers.

3. *Standpipes and Hose.* Valuable protection can be secured from properly installed and maintained standpipes and hose both against interior as well as exposure fires. The standpipes should be of sufficient size to give a



A MODERN AUTOMATIC SPRINKLER:

A. YOKE
B. BODY
C. DIAPHRAGM
E. GLASS VALVE
F. MAIN STRUT PIECE
G. HOOK ON STRUT
H. KEY ON STRUT
J. DEFLECTOR

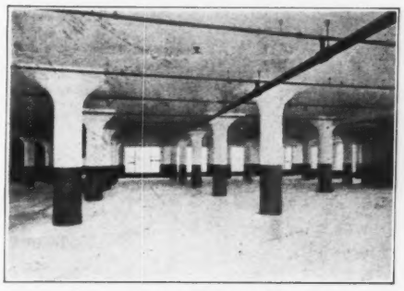
good stream from more than one outlet at once. The usual size is four inches and they should be located so that one hundred-foot lengths of hose will reach every point in the building. The hose should usually be one and one-half inches in size as it is much easier to handle than larger hose and wastes less water should it have to be abandoned during a fire. It is essential that the standpipe be kept in commission with water right up to the hose valves. Where public water direct from the street main is available, this is the best supply to the standpipe. Tanks or pumps in the building can be used in the absence of connection with city water. In high, fireproof buildings it is generally desirable to install a six-inch standpipe with two and one-half-inch hose as the firemen make use of them instead of dragging hundreds of feet of hose up through the building. These standpipes are, in most cases, maintained without water in them but are equipped with a steamer connection at the base so that the fire department can couple on their hose and pump in with an engine or use the high pressure system. Roof hydrants equipped with monitor nozzles are particularly valuable on flat roofs in heavily exposed localities such as dock warehouses, and lumber yards.

When installing apparatus it is most important that it be located so as to be prominent and readily accessible.

Automatic Sprinkler Protection

The automatic sprinkler in forty years of actual performance may easily be classed as the most important of all fire protection devices. With the rapid growth of our manufacturing plants and mercantile centers the increasing needs of better fire protection were fully recognized. Realizing that the most effective way to cope with a fire was to extinguish it in its early stages, to throw water directly on it by some device automatically operated by the heat of the fire, a number of inventors developed the automatic sprinkler. The first sprinkler to be used, about 1860, was the perforated pipe. Lengths of perforated pipe were placed close to the ceiling and divided into sections, each section being controlled by a valve located outside of the building. Naturally there was a great waste of water and the systems were in no way automatic. The automatic sprinkler was first used extensively about 1874 and since then hundreds of patents for sprinklers have been taken out but there are today only about twelve on the approved list of the National Board of Fire Underwriters. The modern sprinkler is a device which, when heated to a predetermined point, will automatically release and distribute a stream of water. This releasing is accomplished by the melting of a solder link which fuses at a temperature of about one hundred fifty-five degrees F.

The water is fed to the sprinklers by a system of piping attached to the ceiling, the sprinklers being placed upright at intervals along the pipe, one sprinkler to protect eighty square feet of floor area. The spacing of sprinklers and sizes of pipes are governed by well-defined rules issued by the Fire Underwriters and based on extensive study and experience. It is essential that sprinklers be placed throughout the building that there



AUTOMATIC SPRINKLERS INSTALLED IN A FIRE RESISTIVE BUILDING

may be no place where the water from a sprinkler cannot strike the seat of the fire.

Concealed Spaces

So far as possible these spaces should be omitted in new construction and eliminated in existing buildings. The danger is in the practically uncontrollable spread of fire in concealed joist channels and behind wood furring. If wood, lath and plaster or metal sheathing must remain it should be kept in good repair so fire cannot readily get into the concealed spaces. Concealed spaces on ceiling: The joist spaces to have plank "stops" at intervals not exceeding thirty feet. Concealed spaces at walls: To be tightly shut off at each floor by heavy plank "stops" or two courses of brick.

Skylights

Burning brands and other material easily break the plain glass skylights and fall into the building. The method most widely used to protect against this hazard is to substitute wired glass not less than one-quarter inch thick for the plain glass. Another method is to place heavy wire screens over the glass. Screens to be firmly supported on iron rods or angles six inches from glass. Finer screens should be placed below to protect persons from falling glass.

Unprotected Wall Openings

The importance of fire walls in preventing the spread of fire and the fact that they are liable to be severely exposed to fire for considerable periods, makes it essential that all openings in these walls be protected by the most efficient methods. All existing openings which cannot be permanently closed should be protected by "approved" fire doors on each side of the wall. The most common type of fire door in use is the two or three-ply wood, tin clad door. This door is two inches to three inches thick and is substantially constructed, practical under most conditions and easy to install. Doors on both sides of the wall furnish a high degree of resistance to fire. These doors are hung on heavy hardware securely fastened to walls. Either the sliding or swinging type of door may be used. All doors should be equipped with an automatic closing device which is arranged so that when releasing device, a fusible link is operated by heat, a sufficient excess in weight is exerted, by the releasing of iron weights, to pull and latch the door closed. All other openings through walls such as shafting and belt holes should be made as small as possible, and in the case of openings for fairly large belts, the openings should be protected by two approved sliding doors coming together in the middle of opening. Slots in the doors are provided of sufficient size to permit the free passage of belt.

Unprotected exterior wall openings in a building which is, or liable to be, subject to an appreciable exposure are a constant menace.

Windows, especially, need protection, not only against fire in other buildings, but also to prevent fire spreading from story to story through wooden window frames and plain glass windows. Perhaps the most popular method now in use to protect window openings is by wired glass windows in metal frames. It has often been demonstrated that for severe exposure double protection is needed such as (*a*) "approved" wired glass windows, protected by tin clad or sheet metal shutters; (*b*) "approved" wired glass windows and window sprinklers. Generally speaking a single form of protection will suffice either the wired glass window or window shutter. The advantage of the wired glass windows over shutters is the fact that they are generally closed, at least at the end of the day; they can be quickly and easily operated; are not unsightly, and can be used on all windows except show windows.

The importance of providing adequate protection for openings in divisional and exterior walls cannot be too forcibly emphasized. When automatic fire extinguishing equipment fails and fire departments cannot stop the fire, fire walls and protected wall openings are the last line of defence.

When the building has been struc-

(*Continued on page 374*)

INDUSTRIAL WASTE RECOVERY

By WILLIAM J. ABBOTT, JR., '06
Research Engineer, Wilton, New Hampshire

WASTE by non-commercial standards might be either something of no value to be discarded or something of some value avoidably or unavoidably lost. Garbage for a modern city dwelling family is of no value. Its possible values as fats, fertilizer, etc., do not exist for them, since they cannot be profitably recovered on a small scale. The sifting of ashes, prohibited in some thickly settled sections, represents a possible recovery of fuel value that is lost, not because the value does not exist in a form practical to recover, but because arbitrary rules prevent.

To the manufacturer waste is entirely an economic factor that may range from the spent liquors of chemical plants or tanneries to by-products such as glue and tankage from the packing industries, and major products such as cotton or linseed oil from the cotton and flax industries. Waste recovery methods have, of course, been forced on certain industries due to the noxious or poisonous character of their wastes, but the commercial vision does not readily see wastes in any other form than the black or red figures of profit or loss. It is the vision of the engineer or inventor that finds a lure and an opportunity in apparently valueless material heaped in dumps or flowing in drains.

On a still larger plan the cycle of creating and recovering wastes can be seen to follow the specialization of our industrial life. Within the life of men now living millions of feet of our finest hardwood forests have stewed to charcoal in crude "Beehive" ovens or were heaped and burned *en mass* to clear the farm lands. Clouds of fumes distilled at the higher temperatures of smelting poured from the stacks of metal reduction works and devastated the surrounding vegetation. Raw material for a hundred years of color production has been vented from coking ovens. With new industries developing came vast dumps of culm or dirt from coal mines. Spoil from mines and smelters encumbered the ground or washed into streams. Packers and tanners polluted other streams with noxious solid and liquid matter. Filters set to make the sewerage of towns and cities innocuous were in turn clogged and rendered ineffective by scouring wastes from woolen mills. Sanitary as well as economic reasons gradually forced industries to make their wastes harmless or turn them to profit. The pressure came from without rather than from within, and just so long as a bustling public did not find itself too inconvenienced or the push of necessity was not too keen, the manufacturer or raw products producer took the line of least resistance.

Gradually, however, one industry after another has had to fall into line and find that to survive, every particle of material on which labor was expended or processing was performed must return a profit. The old rule of thumb operator could not analyze the new conditions of processes or labor reactions, so chemists or engineers had to be added to manufacturing staffs until today practically every major industry has built into it the organized principle of the saving of every dribble of capital or labor expense. The chief laggards today are probably the textile industries, the tanners and the farmers, including in this last the producers of rubber, cocoanut oil and similar raw products now being produced in part under scientific control. It is true that these industries labor under certain handicaps of long established procedure, and lack of markets, or what is the same thing, the lack of advertising or creation of new uses for their wastes. The tanner as well as the farmer, both operating industries as old as recorded history, have had to fight up through an incrustation of ages of rule of thumb empirical methods, secrecy and ignorance. We can wonder who discovered and put into operation the first "back to the farm" cycle with the return to the soil of the manure of man and beast, a cycle now uneconomic in many countries through the development of chemical fertilizer and power pulled farming implements. The tanner working generally with one of the major products of the food industry has yet failed to establish any economic cycle and aside from a few minor products such as degras, the spent grease from oil tanning, his waste is still a nuisance.

The latest, and what may seem to us now the final, step in the handling of wastes, has come with the use of research, a further specialization of the work of the chemist and engineer. Taking the application of technical methods as a premise and establishing them as a means to directly examine data from the daily running of the plant and that taken under experimental controllable conditions the research worker has pushed along definitely chosen channels by the accretion methods of scientific investigation. The work of investigation has followed two main methods, one the deduction of working principles from the mass of undigested facts available and the other the speculative bridging over new ground for unsuspected relations and their quantitative measurement.

The research laboratories stimulating the electrical, chemical and photographic industries, probably represent the most highly developed types. Their relation to the problem of wastes seems less direct only because the problem has expanded into such an intimate network, touching every operation, so that it has almost ceased to be an entity. Crude wastes have practically ceased to exist in the highest industry types, having either been raised a stage to by-products or a further stage to principal products. The location of a smelter working sulphide ores may be conditioned as much by a market for sulphuric acid as by its location to the ore beds. The Ford Motor Company, with the completion of its steel making plant, wood distillation plant and other refinements represents an approach to the ideal wasteless industrial unit. Were our interdependent but separately managed industries operated on a similar co-operative plan the United States could save enough to wipe out its national debt in the life of one administration.

We can look forward with considerable confidence to a more and more complete elimination of wasted effort and material and to a constantly widening field of effort. Present and future generations of technologists specializing on wastes will multiply and diversify, but need have no fear of working themselves out of a job or losing the material for combat necessary to keep them mentally fit.

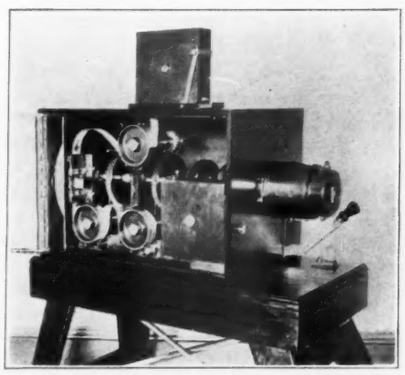
Orders Aggregating $200,000,000, have been placed in this country by the Japanese since the earthquake. The great bulk of all orders placed by Japan has come to the United States. While a portion of this business reflects Japan's appreciation for the aid extended by this country at the time of the disaster, it is thought to have been influenced mainly by the willingness of American manufacturers to quote pre-disaster prices. In other countries bids reflected the sharp advance in materials which came with the anticipation of the Japanese demand.

— *Power.*

THE HIGH SPEED CAMERA

By S. FRANCIS JENKINS
Radio Pictures Corporation, Washington, D. C.

AS is generally known the standard rate of motion picture cameras is sixteen exposures per second. Several very good cameras have been made, both here and abroad, which increase this speed to a maximum of eight to ten times normal speed, which is as fast as the film-moving



FOUR THOUSAND PICTURES A SECOND HAVE BEEN MADE WITH THIS CAMERA

mechanism can be made to go. The Bell and Howell camera, an American product, is doubtless the best example of this type of intermittent camera.

These pictures, which have come to be known as "slow motion pictures", because of the comedy pictures obtained thereby, have come into considerable use in the theatre. They have, however, been of little value in science and engineering, because the speed of the film through the camera is too slow to be of any great value. They are comparable to examining a small object under a reading glass, when a microscope is needed. For this reason several attempts have been made to build higher speed cameras, but because it is obvious that continuous motion of the film is the only possible method, this is the method which has been adopted in all such efforts.

A German camera of this type has been made in which a series of mirrors are caused to travel in synchronism with the moving film, but as the introduction of the mirrors between the film and the lens limits the camera to a comparatively long focus lens, the speed was materially and definitely limited by this factor. It is reported that five hundred pictures a second can be made with this camera, using a single lens and single strip of film; that double this speed can be obtained by using two strips of film, two lenses and two sets of mirrors. Aside from the complication and the necessity of a special projecting machine, the resultant picture is not as acceptable as it would be if taken from a single point of view.

A British camera has been built and recently tried out which has a disc carrying a plurality of matched lenses, all of which pass in succession in front of a constantly moving film and in synchronism therewith. The film is laid on the circumference of a drum twelve feet in diameter, which makes the machine not only very clumsy, but heavy. It is reported to weigh two tons. However, its greatest drawback is the short length of film available. It would be possible to lap the film in a spiral around this drum, but that introduces additional complication, for the drum must be moved longitudinal of its axis, or an equivalent motion. This camera is capable of very high speeds, for short-focus wide-aperture lenses can be used. It is reported that pictures have been made at a speed of 5000 per second.

The Jenkins high speed camera, an American product, has a lens disc with a plurality of matched lenses mounted therein, which rotates in front of a constantly moving film and in exact synchronism therewith. The film is, however, advanced past the exposure aperture with sprocketed drums. The length of film is, therefore, not limited, and the camera is small and portable, weighing, with its motor, only about one hundred pounds. Speeds above 4000 per second have already been made with this camera, the limit in speed has not yet been discovered. (Patented in 1894—No. 560,800, expired.)

As will be noticed in the photograph, the camera is very simple in construction and ruggedly built, the lens carrier being on one end of a drill rod shaft and the driving motor on the other end of the shaft. The gears for coupling this shaft to the film sprocket shafts are made of hardened steel and of ample size. The motor is a battery motor, and, therefore, the camera can be taken afield.

Several new phenomena have already been discovered by the use of this camera; for example, in projecting pictures of a little girl with a skipping rope, it was observed that the rope loop after it dragged along the ground accelerated much faster than the other parts of the rope after it had left the ground. The question very naturally arises "where did it get the energy to accomplish this". It was also observed that when a person jumps over a stick, not only does he light on his toes to absorb the shock, but that after his heels touch the ground he rises on his toes again and then lets himself down on his heels a second time.

A close examination of a golf club swing disclosed that the club head

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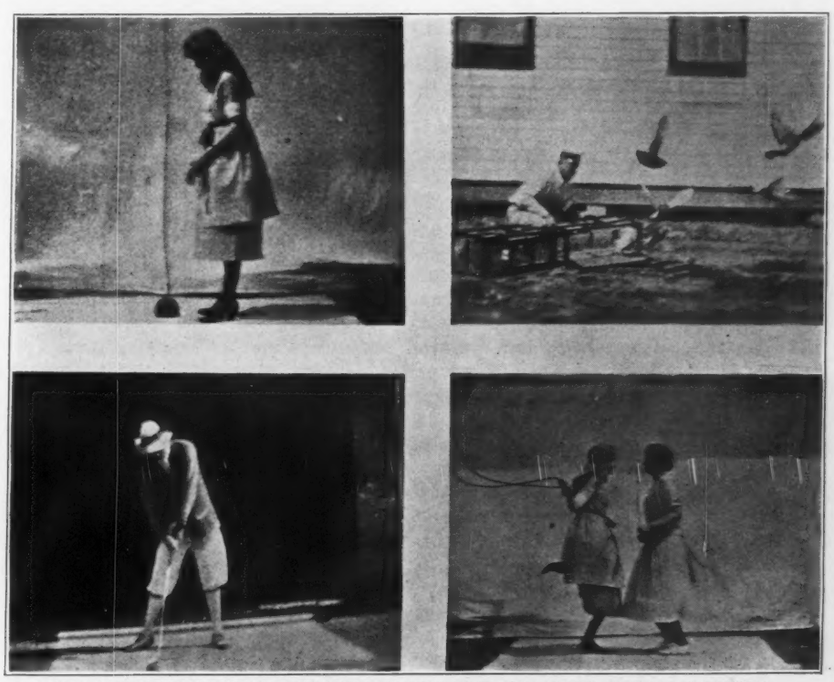

EXAMPLES OF RAPID MOTION CAUGHT BY A HIGH SPEED CAMERA

ALDRED LECTURES

THE PRACTICAL APPLICATION OF AN ENGINEERING EDUCATION

By JOSEPH W. POWELL
Director, The United States Merchant Marine League

PRESIDENT COOLIDGE says, "Civilization depends not only upon the knowledge of the people, but upon the use they make of it." If knowledge be wrongfully used, civilization commits suicide. Broadly speaking, the college is not to educate the individual, but to educate society. The individual may be ignorant and vicious. If society has learning and virtue, that will sustain him. If society lacks learning and virtue, he perishes. Education must give not only power but direction. It must minister to the whole man, or it fails.

President Fallon of Cornell University says: "The object of education is not to teach men to make a living, but to teach men how to live."

In an address delivered last year to the student body at Princeton, Mr. Charles M. Schwab described his house on Riverside Drive, New York, a great stone palace occupying an entire block, filled with works of art, a home representing several million dollars of expenditure. He described his summer home at Loretta, Pa., with its private golf course and wonderful Italian garden with the house in the midst of century-old trees. He told how he had moved the old homestead from the site on which the new and costly house was to be erected without disturbing those fine old trees by jacking up the house and moving it out over the tops of those trees, and then he said "Boys — I don't own that house in New York and that estate in Loretta. They own me!" He meant that these possessions were responsibilities, that they represented the ability to "make a living," but did not show that he "knew how to live."

Very few of us foresee with accuracy the places in which our lives will be ordered. Our early hopes and ambitions are influenced by accident and environment and only a small proportion of us arrive at the end of the road by which we start.

Two old men were talking over the circumstances of their lives. One of them said to the other, "Bill, has a single one of your childish dreams or desires come to full realization?" "Yes, Jim," said Bill, who was totally bald, "when I was a boy my mother used to cut my hair and the process used to be very painful. I always used to wish that I didn't have any hair."

A large percentage of the men who go through college do not follow the vocation that they then choose as their life work. A lawyer becomes a financier and then an educator, a clergyman becomes an officer in the navy and an eminent engineer, a chemist becomes a salesman and then the president of a manufacturing company, and examples can be multiplied indefinitely. My own class at the United States Naval Academy is illustrative. Probably even more than at Massachusetts Institute of Technology, one would expect the members of a class at the Naval Academy to follow the naval profession. Of the forty-three living graduates of my class, twenty-nine are still on active duty. Of the others, there are two lawyers, four farmers, two manufacturers, two engineers, one college professor and three in miscellaneous vocations. Evidently the education obtained by these men who have left the service is not the best suited for their present callings. A considerable part of it is largely wasted and other parts not well applied.

One good reason why general education is so necessary as part of the best specialized course is that we cannot be sure that the special tools, with which our workbox is being filled, will really be the ones best suited to our work in life.

I could never get up much enthusiasm over French and Spanish. In following a career as a Naval constructor I did not foresee any great reason for their usefulness. But, after leaving the naval service, my shipbuilding work took me to Europe and afterwards to Cuba where my poor knowledge of these languages was valuable and where I had occasion to bitterly regret that I did not know them intimately.

There are, however, some branches of learning that afford assurance that the future will bring an ample dividend for the time invested. To know how to think straight and then to put those thoughts in orderly, convincing fashion, either orally or in writing, are factors of highest importance. Moreover, these primary essentials are quite generally overlooked, and I remember very well my reluctance to take time from professional studies for English, for literature, and my entire abhorrence of the idea of public speaking. Every one of you men here before me needs ability to speak clearly and to write convincingly as of primary value in your educational equipment.

In my experience in business it has been a continuing surprise to me to find how few of my men could tell or write a simple narrative of facts, or could set forth a line of reasoning to a well ordered conclusion so that it was easy to follow them. It is also very interesting that most of the men of large affairs are gifted in these particulars. Make no mistake — to be able to think is the foundation of education, but to be able to write and speak these thoughts are two corner stones to put on that foundation.

Two lawyers were arguing a case in a South Dakota court. One was a stranger from Texas, a brilliant young man who all day long had pointed the barb of his sharp wit at the older, slower local lawyer, who found himself at a grave disadvantage against his cleverer antagonist. When the older man arose to address the court towards the end of the day he said "Your Honor, this young man from Texas has treated me with scant respect and courtesy during the progress of this trial. He has made fun at my expense and has held up my words to ridicule, but after all, your Honor, I have no high opinion of this young man. He reminds me of a story told about another resident of Texas. This man had a friend living in a small town in South Dakota whose little son was very anxious to own a horse. The Texan had on his ranch a number o

little burros and decided to send one as a present to his friend's son. He boxed up the little animal, put him in an express car and wired South Dakota, 'Am shipping by express today burro which hope you will accept with my compliments.' The word 'burro' was misspelled in transmission, so the wire arrived, 'Am shipping you by express one bureau,' etc. The express company in due course informed the South Dakotan that a shipment had been received for him. He went to the station, saw the crate marked with his name, saw the pair of big ears sticking up between the slats, looked at the little animal and said, 'Well, you may be a bureau in Texas, but you're just a plain jackass in South Dakota.'" And that story probably won the South Dakotan his case.

No education can replace common sense. The best equipped man devoid of this quality is poorly off indeed. Probably every one who speaks in this course of Aldred Lectures will point this axiom, but nothing is more important. It is the third cornerstone on our foundation of straight thinking. One of the Massachusetts Institute of Technology graduates tells the story of the building of a retaining wall by the New York, New Haven & Hartford Railroad. The wall had to be built in fairly deep water where there was a swift current, too swift for a diver to work. The water was clear, but too deep to permit setting of the stones from the surface. Several engineers looked over the job, shook their heads and went away without a plan. Finally an old and uneducated divisional foreman offered to build the wall. He set to work and in a very short time at a very reasonable cost the job was done. His chief sent for him, congratulated him and then said, "How did you do that job when the current was too swift for a diver and the water too deep to see?" "Oh!" said the old foreman, "I just painted the top of each stone white and then the water wasn't too deep to see them as we put them in place."

The fourth cornerstone of our building is our technical education along the lines of the chosen profession. There again, I am afraid there is far too much tendency to specialize too minutely rather than to make the education a firm basis for future study. For some years I have had the honor of sitting with the Advisory Committee of the Naval Architectural Course of this institution and have advocated the stressing of the general education rather than too much emphasis on the highly specialized work. For instance, each shipyard employs one naval architect, who is, or should be, a highly specialized technician. In an industry of the size of shipbuilding, two or three men graduating every year would more than suffice to make up the vacancies in this profession. In each of these shipbuilding companies there are dozens of executive positions calling for a general knowledge of the theory and practice of naval architecture and of its application. There is, in my judgment, too strong a tendency to carry specialization too far in undergraduate work. The department itself should carry out original research assisted by post-graduate students, and such work should not detract from the instruction in broad principles that should represent the primary object of a well-balanced engineering course. May I point out an example from my own experience? After a four-year course at Annapolis, I took three years of highly specialized post-graduate work and was theoretically equipped as a ship designer. Just once in my entire twenty years in shipbuilding did I find myself in a position where I had to design a ship, and even then I could probably have hired some one else who would have done a better piece of work if I had not been equipped with the necessary ability to do it myself.

Do you gentlemen give yourself time each day to read the vital news — to keep abreast of the times, to form a considered opinion on the Bok peace plan, the Mellon tax bill and the hundred and one vital matters that are going forward? I remember very well that in my academic days I never missed the sporting page, yet when Cleveland sent his Venezuelan message to Great Britain, it came as a complete shock — as the first front page item I had bothered with in days. Would not a weekly lecture on current events be time well spent in any educational course?

The whole field of technical education expands from year to year at a truly astonishing rate. When I was studying electricity in the middle nineties, it was possible within the time allotted to the subject, to cover a comprehensive course that dealt with the entire science as then developed. Today this same course would be most elementary! Whole branches of electrical knowledge more extensive than the entire course of thirty years ago are now included in the known art. No man today can cover the known field and specialists are recognized in many parts of this specialty. A man could spend his entire waking hours studying the developments in electricity and yet fail to keep abreast of the times.

We humans are embarrassed and handicapped by the sad fact that the capacity of the human brain does not increase while the store of physical knowledge grows day by day with increasing rapidity. I asked Doctor Angel of Yale one day last spring whether a greater amount of knowledge could be stored in a college head today than a generation and a half ago. He replied, "Why, Mr. Powell, the human brain has not increased appreciably in capacity in the last thousand years."

So undergraduate education today calls for a careful selection from the vast store of accumulated knowledge of so much of the available subjects as will best equip us to meet our problems in life. It means, so far as every college course is concerned, the building of a solid foundation upon which can be erected a structure that should grow as long as man is alive. Education only begins in our universities and technical schools. Your thoughts of study and your desire to learn cannot be put away when you receive your degree. However carefully the course of study may be devised, much of it will not precisely fit the later need. Much of it will, however, give the unconscious mental equipment that leads to reasoned thought and will thus be of prime value in turning out the well educated technical man.

Straight thinking is our foundation of education with four cornerstones — ability to tell one's thoughts, ability to write one's thoughts, common sense and a broadly specialized education.

When Doctor Fallon said that education was "not to teach men how to live," he emphasized an axiom. The man who uses his education only to make a living is unfortunate indeed. This world is full of interesting things. I can imagine that a good knowledge of astronomy would be of infinite interest. Geology is a science that has ever called me. But life is too short and too many other matters press to make the pursuit of these subjects possible to me. The wise or fortunate man finds his life work in a direction that arouses his keenest interest. Does he love construction work, he follows engineering. Is chemistry his greatest interest, he is a chemist. The man who cannot go to his business each day with a keen interest in what the day will bring forth, and with a love for the work he has set out to do, is indeed an unfortunate man. If his daily task is merely to make him a living, he has become a drudge. If it is to bring him the full measure of happy associations and proud accomplishment, there must be something in it besides a living. We must earn our bread by the sweat of our brows, but there is every reason why we should get a large measure of pleasure out of the process.

Many of the young men who enter this institution have chosen the point of departure of their life work. But my

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THE OPPORTUNITY FOR INITIATIVE IN RAILROAD WORK

By RALPH BUDD
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THE public character of railroad transportation and its intimate relation to the life of all industry, as well as all individuals, justify, if they do not necessitate, its regulation by federal and State authorities. A study of railroad regulation in the United States shows that there have been three distinct periods, in each of which, public policy has exhibited a different conception of how the carriers should be treated in the public interest.

Railroad construction in this country may be said to date from 1830. By 1890, 163,597 miles of road had been built; from 1890 to 1910, 76,696 miles were built; since 1910, there has been comparatively little construction of new roads, the present mileage being 250,480 miles of road. In the early years, there was complete freedom from regulation and, on the contrary, a definite policy of encouragement to railroad promotion. Great inducements, such as land grants and other bonuses, were held out to individuals and companies engaged in railroad construction. The policy of encouragement prevailed practically until 1887, when Congress passed "An Act to Regulate Commerce." This marked the beginning of the second period, which became one of increasingly intensive regulation of railroad financing, operation and rates. The act created the Interstate Commerce Commission and prohibited unreasonable and discriminatory rates. But the first law which gave the commission power to fix rates was the "Hepburn Act" of 1906, which also increased penalties and forbade discrimination and rebates in the form of passes or unfair allowances to shippers. This act has been amended from time to time and is the basis of our present Interstate Commerce laws.

State regulatory statutes had been multiplying rapidly since the eighties, and they, together with the growing intensity of federal regulation, began, during the first decade of this century, to seriously affect railroad prosperity. The effect of this progressively restrictive legislation was substantially to increase the cost of railroad operation. A concurrent circumstance of great importance was the gradual increase in wages and in the prices of materials and supplies. But the regulatory bodies which were imposing more and more conditions adding to operating cost, did not take these things into consideration when fixing rates. Diminishing rates and increasing costs had created a situation by 1909, which indicated the necessity for a substantial increase in rates. This led to the applications for rate increases in 1910 which were denied by the Interstate Commerce Commission. The denial constituted a serious and unusually widespread manifestation of a restrictive policy which rapidly discouraged and slowed down railroad promotion and expansion, and finally stopped it altogether. Railroad credit became so impaired that new lines could not be financed successfully, and improvement and enlargement of facilities could not keep pace with the growing needs of commerce.

By 1915 it became apparent that the public interest was not being well served by this drastic and hostile policy, and Congress began what proved to be the most thorough investigation ever given the transportation question by any legislative body in this country. The War resulted in the roads being taken over and operated by the Government from January, 1918, until March, 1920. It gave opportunity for an experiment in Government operation, which resulted in a practically unanimous public sentiment in favor of a return to private management.

The investigation begun by Congress in 1915 was resumed after the War, and came to fruition in "The Transportation Act, 1920" which became effective March 1 of that year and marks the beginning of the third period. This period represents a public policy toward the railroads different in several important respects from any that preceded it. The Transportation Act further amended the basic "Act To Regulate Commerce," and this latter act, as amended, together with the new provisions of the Transportation Act, constitute the law under which the railroads of the United States now operate. The new provisions of the Transportation Act rest upon the theory that private ownership and operation, with Government regulation, will give the public the most satisfactory and cheapest railroad service. They call for service at cost. In cost of service, however, is included fair compensation for the use of the railroad property.

Here the interest of the public is carefully protected. The amount, upon which a fair return is permitted, is that which the Interstate Commerce Commission itself finds to represent the value of the property devoted to transportation purposes. This, of course, disregards entirely, the amount of stocks and bonds outstanding, but is based upon an investigation and study of the elements of value in each railroad property. The Interstate Commerce Commission, from time to time, determines what it then considers a fair rate of return upon the ascertained value. At present, the return named is $5\frac{3}{4}$ per cent. As a base for the freight rates and passenger fares intended to produce the results contemplated by the law, the aggregate value of all railroad property used for transportation purposes in the United States, or in certain rate making groups, is taken and no consideration is given to the earning requirements of any individual railroad. Thus, the intention is to give the public the benefit of rates just high enough to enable the railroads as a whole, or in groups, to earn a fair return upon the aggregate value of railroad property. The public is further safeguarded by what is called the "Recapture Clause," which provides that should any individual railroad earn in excess of 6 per cent in any year, it must pay one-half of such excess to the Government.

Another important section, which indicates a complete reversal in public policy, provides for consolidation of the railroads of the United States into comparatively few systems. Until prohibited by the "Anti-Trust Act" of 1890, the process of consolidation was proceeding as a logical and natural evolution, because of the economies in operation and the advantages in service it afforded. The large railroad systems, as they exist today, include what were many smaller roads. As specific instances, the Chicago, Burlington & Quincy Railroad, with 9,000 miles in line, comprises what were 178 companies; the Great Northern, with 8,000 miles, 64 companies; and the Northern Pacific, with 6,500 miles, 102 companies. The Great Northern and the Northern Pacific, which together had acquired the Burlington, were prohibited by the Sherman Act from merging into one system. After having been thus arrested for twenty years, consolidation was found, by the study which led to the passage of the Transportation Act, to be a desirable thing and, therefore, was provided for and encouraged in that law.

Consolidation into a smaller number of well-balanced systems will also

facilitate public supervision of the railroads, which is very difficult when there are so many companies varying so greatly in their ability to earn a reasonable return from uniform rates and under uniform regulations. The provision for basing rates on aggregate value and average conditions within certain territories, and that for surrender of one half the net earnings of any company above 6 per cent on the value of its property, clearly are intended to equalize regulative measures, and to help solve the problem of fixing rates high enough to permit some roads to survive without permitting others to make an excessive profit. The plan for consolidation of the one hundred large and several hundred small roads into approximately twelve systems, so constituted as to include some strong and some weak roads in each system, is founded on the same principle and is intended further to simplify the administration of the laws governing the railroads.

The Transportation Act attempts, on the one hand, to insure to the public uninterrupted service and, on the other hand, to insure the railroad employees against any disadvantage from the assumed fact that they should not desert their posts. A Federal Railroad Labor Board is established to hear and decide differences and controversies between employer and employee. It may make findings and issue orders, and may publish the facts relating to violations of its orders; but it is without authority otherwise to enforce them. Public opinion is relied upon largely to bring about the acceptance of the Labor Board's orders by both parties. Notwithstanding the fact that one of the most expensive strikes ever experienced, has occurred since the Labor Board came into existence, it is fair to assert that the Labor Board does constitute a considerable guaranty that transportation service in the United States shall not be interrupted by strikes, and that it does guarantee to the employees that they will not be obliged to accept any reductions in pay or changes in working conditions, which the railroad managements may attempt to force upon them, without review and approval by an impartial tribunal.

Reduced to tabulated form, the following are some of the most important requirements with which the railroads must comply under the laws at the present time:

They must not: without first obtaining permission, change freight rates and passenger fares; decrease wages of employees; change working conditions of employees; abandon unprofitable train service; issue any new securities; remove any existing lines; construct any new lines; consolidate; have same directors or officers as another carrier even though that carrier is owned or controlled; operate ships on the Great Lakes.

They must not: operate ships through the Panama Canal.

They must: detail purposes for which funds realized from sale of securities are expended; surrender one half of all net earnings in excess of 6 per cent on their value; install experimental devices when ordered; make a great number of very elaborate monthly and annual reports covering financial results, operating statistics, boiler inspection, accidents, etc.; publish tariffs according to strict rules; change basis of dividing through rates between carriers when so ordered; furnish switch connections.

Various bureaus of the Interstate Commerce Commission have charge of administering many of these requirements, such as hours of service, methods of keeping accounts, application of safety devices, observance of air brake requirements, condition of locomotives, and other details. The bureaus enforce these regulations by means of inspectors scattered over the country and the railroads are penalized by severe fines for violations.

In addition to federal supervision almost every State has its Public Service or Railroad Commission enforcing innumerable statutes. These state commissions, as a rule, have power to order the stopping of trains at particular stations, the improvement or enlargement of station buildings and other station facilities, and also to stipulate the extent and kind of service to be provided.

These, in outline, are the conditions imposed upon the railroads. Working under and in compliance with them the task of railroad officials is to find a way to satisfy the transportation needs of the country.

What may be called "External" problems are those arising between the Government regulatory bodies and the public generally, on the one hand, and the railroad management on the other. For example, there is constant pressure to reduce rates. Information must be furnished to the Interstate Commerce Commission showing the effect of these proposed reductions and why many of them cannot be made. Adjustments of rates often are necessary and always are being made to meet varying needs and circumstances. A large share of the time of some of the officers and other employees is constantly given to such questions. Another example is the valuation of the railroads by the Interstate Commerce Commission, which has been in progress for the past nine years. Hundreds of millions of dollars are involved here: Indeed, the solvency of probably more than half of the railroads hinges upon the findings in this undertaking. Some idea of the extent of this work may be had from the fact that about ninety million dollars has been expended upon it, about three fourths of this sum having been spent by the carriers and one fourth by the Government, and it is not nearly done. The alarming increase in taxes, and especially the tendency in some localities to pass an inordinately large part of this burden to the railroads, requires that the matter of taxes be given most careful attention. In some cases, taxes amount to over 10 per cent as much as all operating expenses of the railroad.

In addition to these subjects, a large amount of time is given to the keeping of accounts and records in the prescribed manner, and to the making of numerous reports. A large force is also engaged in inspecting and reporting on safety devices. These details are mentioned only to indicate in a general way the things that must be done by the railroads, extraneous to the productive management of their properties, and of a character that the ordinary business does not need to consider. In the case of a railroad, these so-called "external" problems may be and often are vital to its prosperity, and may threaten its very life.

But we are more concerned here with those which the officials are free to deal with according to their own discretion and which may be called "internal" problems of management. In handling these "internal" problems in an endeavor to reduce the cost of railroad operation, lies the greatest opportunity of the railroad official for the exertion of individual initiative. Whether this field shall be unduly restricted or not has a controlling influence upon the attractiveness of railroading as a life work.

Within the limitations prescribed by law, the officials of each individual railroad must strive to get and keep the cost of operation down to a point where the rates permitted will yield a fair return upon the value of the property used for transportation purposes. Since rates are based on the aggregate requirements of large groups of carriers, the concern of the individual road is its cost of producing transportation as compared with the average of such cost on the roads in its rate making group.

The principal divisions of railroad operating expenses are: Conducting transportation, which covers the direct cost of train operation, such as dispatching trains, wages of crews, fuel, and locomotive and car supplies, and makes up about one half of all operating expenses; maintenance of

way and structures, which covers the maintenance and repair of all fixed property and accounts for about 18 per cent; and maintenance of equipment, which covers the upkeep of locomotives and cars and comprises about 27 per cent; traffic, general, and miscellaneous expenses make up the remaining 5 per cent.

Freight service is by far the most important item to a railroad, accounting for almost four times as much revenue as passenger service on the typical road, although this proportion is somewhat less in some regions, notably in New England. Furthermore, the expense of passenger service is largely fixed, since the trains are run on regular schedule whether the volume of traffic is large or small. On the other hand, in carrying freight the amount of train service is increased to accommodate the volume of traffic, and it is in this field that there are the greatest possibilities for controlling costs.

In freight service, a railroad manufactures train-miles, but sells ton-miles. The revenue received is dependent not only on the tons of freight handled, but also upon the distance carried, and the product of each ton carried by the miles it is moved gives the ton-miles produced in that movement.

The common units of cost looked upon by operating officials as indices of relative operating efficiency are the cost per net ton-mile of conducting transportation, and the cost per net ton-mile of all operating expenses, including transportation.

Freight transportation cost may be reduced by:

(*a*) Increasing the size of trains.

(*b*) Reducing train delays on the road and at terminals.

(*c*) Reducing the amount of switching.

(*d*) Avoiding congestion.

(*e*) Heavier loading of cars.

(*f*) Careful use of fuel.

Size of trains may be increased by reducing the ruling gradient, by using larger locomotives, and by running trains more slowly. It is a nice problem to determine the extent to which train speed may be increased at the expense of tonnage; and this problem has become very different under time and one half allowances and the Sixteen Hour Law. In this also is involved the speed at which fuel consumption will be at a minimum.

Especially on roads having comparatively light traffic, and consequently long stretches of single track, and on roads with heavy gradients, the question of train delay becomes very serious. Some of the remedies for such delays, stated in approximate order of application, are:

(1) Careful dispatching to avoid bunching of trains at certain times of day, or at certain places.

(2) Education of train and enginemen in the necessity for team-work in the handling of trains, to reduce train delays and to promote safety.

(3) Automatic block signals to provide closer spacing and greater freedom of movement at meeting and passing points with safety.

(4) Proper time interval spacing of passing tracks.

(5) Double track, first at points of greatest traffic density, then from terminal yards to the first water station, and eventually continuously between terminals.

Determination of which additional facilities should be provided and when is made in each case independently, because hardly any two cases present identical conditions. Not the least of the complications, especially on western transcontinental lines, is the sudden and violent fluctuation in traffic, which may be three times as dense in October or November as it is in February. Perhaps there may be need for a certain facility for six weeks in the fall of the year. It often becomes a difficult question to determine whether the advantages for that short period justify the capital charges and upkeep for a facility not needed during the remainder of the year.

It is estimated that a freight car stands still 85 per cent of its life, and spends only 15 per cent moving between terminals. Some of the time it is standing is while undergoing repairs, but even then it must be reckoned with in yard operation, for it must be switched out of the train to the repair tracks or shops and back into service again.

Terminal detentions besides repairs are: Those at loading and unloading points; those at transfer points; and those at operating engine terminals. Prompt loading and unloading of cars to reduce terminal delays at origin and destination, and elimination of unnecessary delays at transfer points require coöperation with shippers and with other railroads. Here is a great field for constructive work. The successful attention given to it during the year 1923 was in no small part responsible for the improved car supply and the resulting improved operating efficiency.

Detention at operating terminals is peculiarly a transportation problem, and offers one of the best fields of endeavor left to the unhampered ingenuity of railroad management. Three principal methods of eliminating operating terminal delays are:

(1) When the ruling grade is the same on two or more adjoining engine runs, the engine runs may be lengthened.

(2) When ruling gradients are different on adjoining districts, motive power may be so assigned as to permit the same tonnage being handled on the different ruling grades, thus permitting trains to pass through the engine terminal intact. The proper assignment of motive power on a railroad is at once one of the most difficult and most important duties of the chief operating officer.

(3) Trains may be made up at the initial or starting point with cars switched together in order of destination, and in train units which can be handled over the limiting engine district. To this unit cars may be added called the "annex," to give the tonnage which can be hauled over the immediate engine district, this "annex" being added to or reduced as necessity requires.

The loading of equipment to its full weight or cubical capacity is very important and will result in great economies. For example, it costs approximately 50 per cent more per ton to haul freight if loaded in carloads containing but fifteen tons than it does if loaded in carloads containing fifty tons each. The saving in equipment is tremendous when we realize that a gain or loss in loading of one ton per car represents a difference of eighty thousand freight cars in transportation service daily throughout the United States. Carload minima are fixed by tariff. Shippers, however, may be induced to load cars more heavily and good results have been obtained from efforts in this direction. In the proper distribution of cars, much can be accomplished by placing the small cars for the small loads, using the heavier capacity cars for heavy commodities or large loads of commodities shipped in bulk.

One other matter of high importance is supervision of the loading, stowing, and handling of less than carload freight, also the supervision in general of the handling of carload freight with the object of avoiding loss or damage and the resulting claims by shippers. Here is a fertile field for constructive effort.

The cost of fuel is about 12 per cent of the total operating expense, varying considerably with the geographical location of the road. Careful supervision of the purchase and handling of coal offers opportunity for great savings because of the large amounts involved. The use of specifications statin6 chemical content and b. t. u. requirements seems to be replacing the practice of specifying merely the districts or the mines from which coal shall be supplied. Expert firing and exact recording of performance are

two of the methods used in saving fuel.

An excellent example of the necessity for weighing different advantages against each other is the adoption and use of the mechanical stoker on locomotives. Experience indicates that about 15 per cent more coal is used on an average when the same locomotive is fired with the mechanical stoker than when it is fired by hand. But the large locomotive is beyond the capacity of one fireman, and even two firemen would have difficulty in keeping up steam on one of the largest locomotives operating on a long stretch of ruling grade with tonnage train. An advantage of considerable value with the mechanical stoker is the fact that it will keep up steam pressure under these circumstances and the same type of locomotive, after being equipped with mechanical stoker, may be given a higher tonnage rating than previously. So the item of fuel cost, which is a very large one, merits the best attention of operating officials; and the technically trained man is best equipped for successfully answering many of the questions involved.

Another field for initiative is that of service on branch lines where traffic is very light. The communities reached by branch lines require a service for both passengers and freight. To provide a less costly method of transportation over lines of light traffic, experiments are being made with self-propelled passenger cars, and some are being operated with fair success. There is opportunity here for ingenuity on the part of operating officers, and the stake is large.

These are some of the ways in which the cost of conducting transportation may be reduced. As that item represents about half of the total operating expense of a railroad, it affords the largest single field for exercise of individual initiative, and owing to the character of the items that enter into it, the opportunity for economy there is probably greater than everywhere else combined. Some of the things mentioned are quite obvious; others may seem trivial; but when one thinks in terms of cost per ton-mile and when he realizes that four hundred billion ton-miles are made on the railroads of the United States each year, which means that a saving of one half a mill a ton-mile would produce a saving of two hundred million dollars a year, the importance of anything increasing economy in ton-mile cost is apparent.

Maintenance of way and structures and maintenance of equipment together represent nearly as large an expenditure as conducting transportation. Maintenance of way practice is fairly well standardized. The Proceedings of the American Railway Engineering Association, including the Manual of Practice, have promulgated widely the standards in use and those recommended, with the result that all of the principal railroads are standardized along similar lines, the variations being for adaptability to conditions prevailing on the different properties. The use of improved devices, like better rail joints, more and better rail anchors, treated ties, tie plates, etc., has reduced maintenance cost. So have the more careful drainage of roadbed and more careful selection and preparation of ballast.

The extent to which these improvements are carried out depends upon the policy of the management, the character and density of the traffic handled, and the financial ability to adopt standards which represent ultimate economy, but at the expense of relatively large capital expenditures. The study of steel rail manufacture is itself a huge problem.

Oxy-acetylene welding is an example of adapting a machine shop appliance to track work. For several years frogs and crossings have been repaired in place by this process, with great saving. More recently, battered rail ends have been rebuilt by welding, and obsolete rail joints replaced by those of modern design to prevent recurrence of the trouble. In this way extensive relaying of rails has been deferred for several years and a tremendous economy realized.

Another improvement in maintenance practice is the extensive use of motor cars in place of hand cars for track and bridge forces. This has reduced the time spent *en route* to the place of work and conserved the strength of the men for productive effort. It has also made it possible to lengthen sections, thus reducing the number of gangs and the cost of maintaining headquarters. In all of these things, of course, judgment must be used to make sure that the saving justifies the expenditures.

Maintenance of equipment constitutes more than one fourth of the total cost of operating a railroad. Its cost has advanced more in the past ten years than either maintenance of way or transportation, which perhaps justifies giving it special attention and study. Shops, of course, represent an immense investment. It may very well be that the difficulty of raising new money and of showing with exactness and certainty the savings to be made from a proposed improvement, together with the fact that existing machinery and tools bought at great cost and still in good condition would have to be discarded, has prevented many railroad shops from being kept entirely up-to-date.

Cost of locomotive repairs may be reduced by use of machine tools of modern type. Another device which saves money is autogenous welding. In most shops it consists of three different kinds; oxyacetylene, by which remarkable pieces of work are done, such as welding broken cylinders intact without removal from the locomotives; electric welding in fire boxes of locomotives, where formerly it was necessary to go to the great expense of riveting patches; and thermit welding, whereby broken frames can be welded without being removed.

Locomotives of modern type may be equipped with many auxiliaries, such as superheaters, stokers, feed water heaters, booster engines, grate shakers, electric headlights, etc., which increase the cost of maintenance, but which, if suited to the requirements, increase the ton-miles per unit of expenditures and thus reduce the operating cost per ton-mile. Their net value can be determined only by continued expert investigation and careful experiment. Technically trained men are preëminently fitted for undertaking such work.

In seeking ways to reduce operating costs, the need for additional capital is encountered at every turn. The lack of it, or the difficulty of obtaining it, has prevented the realization of many economies which every railroad executive know he could make if the money for improvements were available. It is not uncommon to hear a railroad executive bewail the fact that the law contemplates the railroads shall earn 5¾ per cent on the value and takes from them half of what they earn in excess of 6 per cent, yet since the law became effective the Interstate Commerce Commission has guessed so poorly on what freight rates and passenger fares should be to yield the contemplated return that the roads as a whole earned less than 1 per cent in 1920, 3¼ per cent in 1921, 4¼ per cent in 1922, and probably 5¼ per cent in 1923. On the other hand, higher levels of interest rates following the War, together with the uncertainty of return on railroad investments, have made it necessary for the railroads to pay an average of about 6 per cent for borrowed money; and have made it impossible, except in extraordinary and isolated cases to obtain railroad funds in any other way than by borrowing. This is true, but it is a condition not wholly without virtue. The necessities of the railroad situation following the War have compelled all possible ingenuity and initiative on the part of railroad managements and it seems fair to say that some, at least, of the benefits would not otherwise have been realized. An analysis of the financial dilemma just mentioned may show it not

altogether so hopeless as the bare statement indicates. Of course, to borrow money at upwards of 6 per cent interest to improve property which government regulating bodies permit to earn only 5 per cent would be a short cut to receivership. Certain improvements, such as grade separations, paving,and other public improvements, and safety appliances on equipment and roadway required by ordinance or statute may not give much return, but railroad managements can find an abundance of opportunity for making additions and betterments that will yield a return double or triple the interest rate high as it is. A common plan is to fix an arbitrary rate, say 15 per cent, which the estimated increases in net income will show upon the new capital invested, as a condition for approving the expenditure.

Instead of dividing operating expenses into the different primary accounts, which I have been discussing, they may be separated into the items of labor, which makes up about 63 per cent; fuel, about 12 per cent; other materials, about 18 per cent; and miscellaneous, about 7 per cent. Labor is far the largest item, and the methods of reducing operating expenses that I have been discussing, namely, by getting more service from the existing plant and by judicious enlargement and improvement of facilities, must, in order to accomplish the results intended, get more output per unit of labor applied. Without considering wage reduction at all, any successful method of improving railroad operating figures must produce lower labor costs and to do so must rely largely on the effective application of the employees to their various tasks, because the pay roll is such a large part of the total expense.

The field for individual initiative in the operating department is surely very great. Other departments, such as traffic, accounting, legal, and purchasing, also offer like inducements. But I am considering especially the operating department because it directs the expenditure of such a large part of the total controllable outgo and because, including as it does the offices of the civil, mechanical and electrical engineers, and also conducting transportation, it is the department which men from technical schools naturally would enter if they choose railroading as a career. No one can say what path leads upward quickest and surest in a railroad organization, nor can he in any other business. The outstanding feature of our American life is the opportunity for achievement that is open to all. The railroad field is no exception. There are five thousand positions on the American railroads paying six thousand dollars per year or more; nearly every one of them has possibilities for advancement. Keeping in mind that the principal sections of the operating department are the transportation, civil engineering, and mechanical engineering, the man with technical training may enter the civil or mechanical engineering section and rise eventually to chief, after which he may become general manager; vice-president, or president; or he may enter the transportation section either at first or by transfer from another section of the operating department, or from another department of the railroad. Here the normal channel of progress is upward to superintendent, then general superintendent, general manager, vice-president, and president.

Promotion, of course must depend mostly upon the individual, but the records indicate that the operating department is the best training ground for railroad executives and that the engineering department has been a favorite starting place. Statistics of thirty-five principal railroads having over 80 per cent of the total mileage of the United States show the following:

PRESIDENTS OF RAILROADS

	1890	*1900*	*1910*	*1920*
*From Operating Department	20	26	27	26
†From Engineering Section	5	8	5	11

*(including Engineering)
†(included in figure above)

On the basis of mileage, a larger percentage of the railroad property of the United States is in charge of chief executives who formerly were in the operating department than these figures indicate.

One great advantage in advancing through the transportation section of the operating department is that the position of superintendent is in itself such a satisfactory one, especially on roads having the so-called "Divisional" plan of organization. The superintendent actually is in charge of a considerable portion of the railroad. He is responsible for the upkeep of the property as well as for the handling of trains, and he is largely held responsible for the cost of operation. Except financing, he touches every problem of railroad management and has unexcelled opportunity for development.

By its very nature, a large part of the knowledge necessary for successful operation of a railroad must be gained from actual experience in the work. A technical education will serve as an aid, but cannot avoid the necessity for gaining this knowledge through experience. As labor costs represent the greatest proportion of the total cost of operation, the willing spirit of labor has the maximum of bearing upon the output and the cost thereof; hence an exceedingly important part of the business relates to the successful dealing with employees. The superintendent who has the proper experience as a background and has, in addition, technical training, has reached a point where he should be able to realize upon his investment in education. Here, as elsewhere, the rule holds good that hard work is an absolute essential to success. No one works harder or longer hours than a good Division Superintendent on a railroad.

This brings me to what is probably the most important thing in connection with the whole subject of railroad economy — and that is the human relation. It is not confined to any department,and while largely belonging to what I have chosen to call "internal" problems of management, it is not wholly so. An important provision of the present law is that if the employees and the management cannot agree on wages and working conditions, the dispute shall be taken before the Labor Board, which will decide it. Without discussing the necessity or value of the Labor Board, it can hardly be denied that peaceful negotiation and settlement by the employees and the managements of the greatest possible number of questions is most desirable from the standpoint of both parties.

The finest cars and locomotives, the latest appliances in shops, the amplest and best maintained tracks and structures, and the cleverest distribution of motive power may lose much of their value through failure to obtain and keep the goodwill of the men who maintain the property and operate the trains. There is no panacea to cure the ills of employee relations. Perhaps the one absolute essential is that the official directly in charge of employees shall have faith in them; be loyal to them, and fair and impartial in all his dealings with them as he is with this company. A feeling of reciprocal friendship and coöperation is worth more than the strongest wage contract ever made. Men do not give their best efforts for mere pay in money, but for the love of accomplishment. First of all the elements that go to make a success in the railroad business, as in any other, is to be passionately fond of the work. Planning for the future and impatient anticipation of an opportunity to realize improvements which will make for better and better service, must be regarded as one of the highest forms of pleasure and not as slavish toil.

There is no reason to believe that the importance of railroad transportation in this country will diminish. The romance which attached to the conquest of the great plains and mountians is gone, but the far-flung

influence and contact with distant communities inherent in the conduct of a large railroad system hold an alluring charm. They may be considered the logical heritage of those who have come after the great pioneer builders and who are witnessing the realization of the dreams those men had of development that was to follow the advent of the railroad. There will always be need of additions and improvements to the railroad system of this country; some new roads should be built, and refinements and economies in operation always must be sought and applied. The standards of living in this country demand the best railroad service in the world. The remoteness of its centers of population from each other and from its areas of production demand the cheapest. What greater field of endeavor should a young man seek?

APPLICATION OF AN ENGINEERING EDUCATION

(Continued from page 363)

advice to each of you is, to be as sure as you can, that you are choosing a vocation you can love and that you are undertaking that part of the profession that best fits you. I would rather be a happy and satisfied second class artist earning one hundred dollars a month than an unhappy and dissatisfied chief engineer earning one hundred thousand dollars per year. The most contented man I ever met was a machinist who was making five dollars a day, who loved his work and his family and who gave all there was in him to both. The capacity for happiness and contentment is largely from the inside and not from the outside. Make no mistake, neither fame, nor power, nor wealth bring happiness in their train. We must achieve these in quite other ways. If I could give one piece of advice for each of you to follow, it would be to learn to smile, no matter what may happen. A man can smile and still be a fighter. The outstanding characteristic of our American troops in the great war was their cheerful happiness when there was the least chance. They went to the front singing and laughing and many a man died with a smile on his lips.

I remember one day in January, 1918, I was on my way east from San Francisco. I had spent the night in Milwaukee with a man who was doing some vitally important work for our huge destroyer program. In the morning on the way to his plant I asked him to stop at the hotel where my telegrams were to be sent, and there found a large number awaiting me. As we rode along, I opened one after the other, and each one was a record of something that had gone wrong and each succeeding one seemed worse than the one before. Finally the last one told a story of a hundred-ton crane that had fallen across the deck of a ship. It had narrowly escaped sinking a destroyer, and the accident had crippled the yard for some precious days. As I read that message I laughed and handing it to my friend said, "Well, that is the limit." He read it and looked at me in amazement and said, "And you can laugh!" I said, "Yes, there are a dozen men worrying their hearts out to get that crane repaired and I can't do a thing to help them except send them a wire to 'cheer up', and I am going to forget that and see what I can do today that is useful." Now I was, as a boy, and still am, a good deal of a worrier, but I consider that just insofar as I have overcome that fault in my way through life, just as far I have strengthened myself and increased my ability to live happily. When thought and attention can't help a situation, learn to accept that element and go on to the next.

Roger Babson recently wrote as follows: "Blessings that civilization spreads broadcast along our way are not beneficial if they merely create unsatisfied desires. Some of the greatest scholars, statesmen and spiritual types we have known emerged from humble surroundings into lives of patient toil and thought, and in success never forgot their early training. The young man and woman who would be truly great may become so without special education or inherited wealth, for greatness lies in service. The family that lives and works within itself need not fear the social climber, for this often ends in strained finances and an ignoble fall. Poverty is hard to bear, but it is no disgrace. Riches do not make the man. Education that does no more than confer degrees for knowledge attained is misplaced. Ever seeking for something 'higher,' something that is the fad or fashion, something that gives hectic pleasure rather than gentle joy, distorts our social life, disorders the natural economics of our commerce, and puts our business and financial endeavors upon stilted foundations. We want to begin at the top of the ladder and are unwilling to ascend from the ground. Take this thought in all its bearing and will it not explain much of our complaining over 'inequalities,' over contrasting standards of living, over rich and poor, over capitalist and working man?"

Don't go forth from your courses in this institution expecting to achieve great success in a minute. A man must learn to follow before he is fit to lead. The best book education leaves vast realms of knowledge that only practical experience can teach and without which a man is not fitted to direct large undertakings.

Our modern courses give little weight to what I may call the spiritual side of education. I sometimes wonder how far we might go, with advantage, in impressing on our undergraduates something of the many difficult moral problems that must be met in business. A well known and successful merchant once said in my hearing, "Our modern business ethics are complicated in the extreme. Why if white was right, and black was wrong, all my life I've been living in the gray." How far are we bound by laws whose very interpretation are matters of judicial decision by the highest tribunal, when often the court itself divides on the meaning? When is competition so desperate that it becomes more unfair than combination? How shall we differentiate our responsibilities to labor, to capital and to the public? When is it fair to take advantage of a tax law to reduce our obligation to pay and when is such action mere subterfuge? To take away with us from our college course a fair measure of principles on such questions is a matter of vital importance. But so far as I know, we are all turned adrift to settle these questions according to our own lights in the rough school of experience.

Above all, as you go through life, have time to make and keep real friends. They are the finest achievement of a successful career, and while business friends will seldom fill the places that our classmates occupy, the associations of our later years leave many opportunities to form new attachments that make life worth living. And we can take out of our lives only those things that we put into them.

In closing I hope every one of you knows by heart Kipling's greatest poem "If" and that last verse —

"If you can walk with crowds and keep your virtue,
And talk with kings nor lose the common touch,
If neither foe nor living friend can hurt you,
If all men count with you, but none too much.
If you can make each unforgiving minute
Show sixty seconds' worth of distance run,
Yours is the earth and everything that's in it,
And what is more — you'll be a man — my son."

MONTHLY NEWS

Oil from Shale and Oil-Soaked Sands. Much interest has been manifested in the possibility of the application of the Bowie-Gavin cracking process, developed by Interior Department engineers at the San Francisco office of the Bureau of Mines, to the simultaneous recovery and cracking of oil from oil-soaked sands and shales. Should the production of crude oil in California and elsewhere decline with an attendant increase in the price of gasoline and other oils, it will then be feasible to market oils extracted from such deposits. It has been estimated that there is sufficient oil in the sands and shales to supply the needs of the world for several centuries even though the present wells cease production entirely.

Rubber Growing in Florida. Steps are being taken to begin the growing of rubber in Florida to augment the available supply and also to make the rubber industry less dependent upon the foreign market. The trees grow very rapidly in the State and have practically a twelve months growing season. An investigation is to be made to see if this cannot be made an industry of importance to that territory.

Novel Uses for Ultra-Violet Light. With the recent development of powerful sources of ultra-violet light there have come many uses of industrial importance. The most outstanding of these is the testing of the permanence of colored fabrics by the rays. Fading qualities of fabrics were formerly determined by exposing them to sunlight for a long period. Now, however, the same test may be applied by the use of the ultra-violet rays, completing the process in a very much shorter time.

The most interesting applications are those connected with fluorescence. Many substances glow quite brightly when exposed to the rays in a dark room, the color and intensity of the glow affording a means of distinguishing one from another. It has been demonstrated that by this means artificial pearls are at once distinguished from natural ones, and it is even possible to distinguish Oriental natural pearls from Japanese cultivated ones. Stones of the same kind do not fluoresce identically if they come from different regions, so that it is possible to tell whether two diamonds came from different regions or were cut from the same stone.

— *Scientific American.*

Vast Irrigation Scheme in India. One of the world's largest dams is being constructed in India, to control the waters of the Indus and to aid in the irrigation of vast tracts of land at present unproductive. This dam will be known as the Lloyd Barrage in honor of Sir George Lloyd, Governor of Bombay.

The dam itself is nearly a mile in length and seven hundred feet high. The flow of the Indus will be controlled by 66 gates each weighing 50 tons. Immediately above the dam seven canals will carry the silt-laden waters over large areas of the province of Sind. The Rohri canal will be 205 miles long with 2,300 miles of branches. The central rice canal is to be 87 miles long and will irrigate 500,000 acres of the finest rice growing land in India. Similar waterways will radiate in all directions from the central reservoir.

The scheme is being financed by the government of Bombay, the estimates calling for $60,000,000, of which $17,500,000 will be spent upon the dam.

Repeating Radio Concerts. KFKX, the Hastings, Nebraska, station of the Westinghouse Electric Company is probably the most unique broadcasting station in the world. It serves as a connecting link between KDKA and the fans of the West. KDKA, which broadcasts at 920 kc., transmits its high frequency wave to Hastings on 3,200 kc. Hastings repeats on 1,050 kc. frequency. A feature of the high frequency broadcasters is the small antenna used, it being not over 35 feet in length. Not only can KFKX repeat concerts from KDKA, but it can serve as a booster station between KDKA and a transmitting station of the Pacific Coast. It can also broadcast concerts from its own studio.

The transmitting set at Hastings consists of three panels, the rectifier panel, modulator panel, and the oscillator panel. The rectifier converts the high voltage A.C. current received on the antenna to high voltage D.C. current for the plate circuit. The modulator with its accessories impresses the voice frequency on this high voltage D.C. current before it goes to the oscillator. Finally the oscillator converts the D.C. current to radio frequency in which form, it is delivered to the antenna.

One of the difficulties attendant upon high frequency broadcasting is that every precaution must be taken to eliminate any outside influences such as vibration that would change the frequency. The set of KDKA is suspended upon a system of springs so that vibrations of the nine-story building in which it is located cannot affect the frequency.

— *Westinghouse News Service.*

Bay of Fundy Tide to be Used to Develop Power. The first application to reach the Federal Power Commission proposing any development of power by using the tide has just been filed. The application covers a project on the Bay of Fundy, near Eastport, Maine, calculated to develop 400,000 h. p.

The project involves the construction of five miles of dams which will connect the mainland with Deer and Porto Bello Islands and cross Lubeck Channel to the mainland. The power house is to be constructed between two pools which will be created by the dams. The range of the tide at this point is in excess of 30 feet. By the operation of these pools it is calculated that a flow of 200,000 cubic feet per second can be obtained and a head of from 16 to 27 feet secured. — *Power.*

Super-Apparatus for Super-Power Systems. Now that there is a movement on foot to make the super-power system a reality, it is interesting to know that apparatus for handling the voltages necessary for handling super-power has already been made. Six of the largest types of oil circuit breakers have been installed on a western system. The tanks of the breakers contain 2,000 gallons of oil and are made of 3/8-inch boiler plate

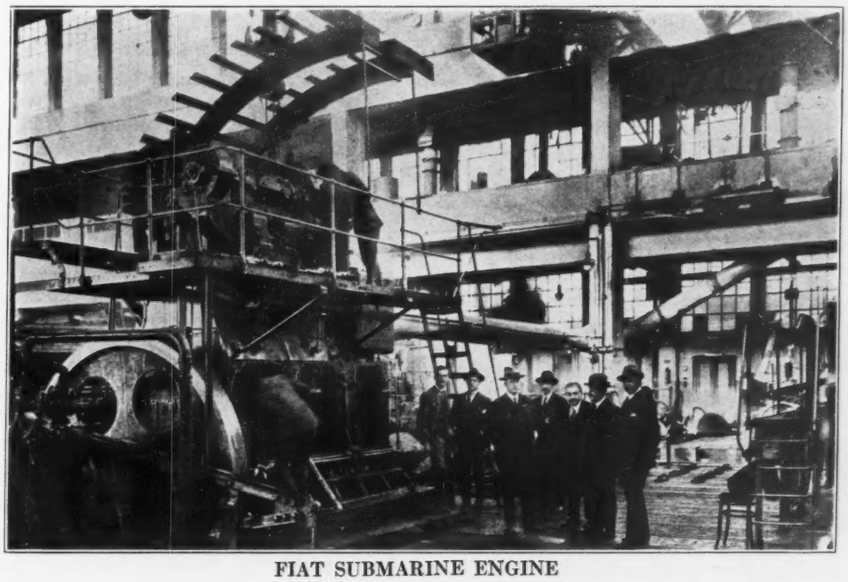
with welded seams. Each breaker has a double break of 30 inches. The contacts are of the quick-break type which gives the maximum speed for actual interruption of the circuit. The high tension bushings are of the condenser type, protected from the weather by porcelain weather casings. The bushings are a solid column made by cementing together individual units. These breakers will interrupt a short circuit of 2,400 amperes at 220,000 volts. — *Westinghouse News Service.*

Wood Colored as it Grows. A report from Dresden intimates that a German engineer has succeeded in coloring wood as it grows. Living trees are given any desired color by this process. It has been found that a whole tree from the end of its roots to the topmost leaf can be completely and permanently colored in forty-eight hours by the application of the dyes. An aniline dye is used and 50 grams of dye with 200 litres of water are sufficient for one tree. The process has been patented and will be put to use at once in the manufacture of furniture and various wooden articles. This treatment affords an excellent means of imitating certain natural woods. — *Scientific American.*

Ford Factory Electrically Heated. The factory of the Ford Motor Company at Green Island, N. Y., is heated by hot water which is heated electrically. The outer exposure of the building consists of about sixty per cent glass; 65,000 square feet of radiation is installed. The water is circulated through two electric heaters, either one or both being used, depending upon weather conditions, and is raised to temperatures of from 135 to 153 degrees Fahrenheit. The heaters are of the water-resistance type, having a capacity of 3,200 kw. each, and are operated at 4,600 volts, 60 cycle, three-phase. The electrical input is controlled by the level of the water in the boiler exactly as in the case of a steam generator and independent of the pump pressure.—*Power.*

Fiat Submarine Engine Has Five Hundred Shaft Horse Power Cylinder Output. The Fiat Company of Turin has recently begun the work of developing and building oil-engines for land and marine purposes. One of the latest to be placed on test is a two cylinder, experimental engine of 1,000 b h.p studied and designed for propulsion of the new cruiser type submarines of the Royal Italian Navy.

It is a two-cycle engine, having an output of 500 b.h.p. per cylinder, the highest that has as yet been obtained from any other submarine engine cylinder and means that 4,000 b.h.p. can be obtained from an eight cylinder unit. A practical demonstration of the reliability and efficiency of this engine was given by a non-stop run of twelve days, four days being at full load and eight days at nine-tenths load, with short periods of overload.



FIAT SUBMARINE ENGINE

The total run was equivalent to a 5,000 mile sea trip.

The framework over the engine in the photograph gives an idea of the dimensions and internal shape of the engine-room, and indicates the small space available for erecting and overhauling the engine in service.

— *Motorship.*

The Cement Production for 1923 set a new record. The demand throughout the entire year was extraordinarily heavy, yet the demand was met and prices were kept low. In the first eleven months of 1923 production of Portland cement amounted to nearly 127,000,000 barrels, an increase of twenty per cent over the same period of 1922. Shipments were 17,000,000 barrels in excess of the corresponding period of the year before.

BOOK REVIEW

Corrosion Tests and Materials of Construction for Chemical Engineering Apparatus. By W. S. Calcott, J. C. Whetzel, Chemical Engineers, E. I. duPont de Nemours & Company and H. F. Whittaker, Chemical Engineer, National Research Council. The D. Van Nostrand Company, New York. Cloth, 6 x 9 inches, 169 pages and index. 1923.

This book is a reprint from the transactions of the American Institute of Chemical Engineers, volume 15, part 1, and contains a good presentation of the work which has been done in the laboratories of the duPont Company upon the subject of chemical corrosion. It leaves atmospheric corrosion entirely out of the question dealing only with chemical corrosion, and in this manner making itself valuable to chemical engineers interested in the design of apparatus to best resist corrosion.

The book is divided into two sections, the first section covering the electrochemical theory of corrosion, the theory most generally accepted at present. It gives, quite in detail, the factors which influence the rates of corrosion of various metals. Following this, there is a group of tables containing specific illustrations of these factors. These tables, and the chart which accompany them, show the extensive experience of the duPont laboratories with all the metals and alloys used in the manufacture of chemical apparatus.

The second part of the book consists of a review by one of the authors, Mr. Whittaker, of the various materials of construction and their properties which are used under specific corrosive conditions. It is in the form of a paper, which was read and discussed at the Wilmington meeting of the American Institute of Chemical Engineers, held on June 22, 1923. The included discussion, which follows the reading of this paper, brings out the problems which other concerns have had in designing apparatus for their particular cases.

One of the valuable features of the book is its extensive bibliography of chemical corrosion. For one interested in obtaining collective data upon the subject of corrosion, this book should be a very valuable possession.

EDITORIALS

THROWING ROCKS AT OUR OWN WINDOWS

If the public were suddenly to decide that Mr. W. was making too much money out of his gum, and that he must sell twenty chews for a nickel, and got up an Interstate Gum Commission to see that he did sell twenty chews for a nickel, and also that he carried on warlike competition with Mr. B. and Mr. A. in the matter of supplying our stenographers with their favorite masticatory, and then instituted a different commission to tell him what he must pay his "help"; and if the effect of this regulation were to reduce the mastication to nearly nothing by stopping the production of gum, and to drive the stenographers to the consumption of jelly beans instead, no great damage would have been done to any one but Messrs. W., B., and A. — who, being men of energy and resource, as far as they have personal being outside the wrappers of the gum, would probably get themselves into the jelly bean business and proceed to amass money at their former rate. The public would not be damaged at all because it really makes no difference, in a public sense, whether Tillie the Toiler chews gum or jelly beans or Star, or quits chewing altogether. Nor does it make much difference to the public whether Messrs. W., B., and A. make fortunes or lose them, they being mere individuals, whose social value does not greatly exceed that of their commodity and without whose services the public worried along for many years before any of them got into the gum game. But they are not engaged in the business of transportation; and this dark hypothesis is painted as a background against which to suggest how very different is the case of the railroads of the United States.

And yet, to use an old Arkansas phrase, we have been chewing the ear of the railroads for over two generations; for a large part of their existence since they began, about ninety years ago. We have laws to compel them to compete and others to permit them to combine; we get an important decision under one law after a contradictory one has been passed; we try to tell them what tariffs they may charge and what wages they must pay, each fixed by a different board; we dictate when they shall run and where they may stop; we threaten them with national ownership, or Soviet operation under the Plumb plan; we try to stop their making profits, and insure them profits of 5½ or 6 or some other definite per cent, as though there were something sacred and changeless about how much return capital can innocently make; and when a war comes we find them so reduced in effectiveness that we take them away altogether from their owners and eat up the soft parts and hand back the seeds and core. And it makes a difference. It is not the case of chewing gum. It is playing Aunt Sally with a vital organ of the nation, vital in peace and in war

In this country, products must go long distances. Transportation service is subject to tall "peak" loads at certain seasons. We need rate-making that will give the farmer a chance both ways; and outward bound, he must meet the competition of the world on many of his products. But today we are confronted with car and power shortages, congestion and embargoes, and no fresh capitalization to speak of, can be undertaken because of our arbitrary restrictions on profits. There is nothing for experimental purposes, development trials; nothing for progress. The managers feel they are doing well if they can keep going. They need to be hundred-thousand-dollar men, the best brains in the country, and a bill was introduced in Congress at the last session to make the maximum salary of a railroad executive $15,000 a year. It is wonderful. The bureaucracy in control has even had it made a misdemeanor for anybody to keep any other railroad accounts than the kind prescribed by the bureau; so that an executive that might wish to know more about the operation of his road than the Interstate Commerce Commission prescribes, and that might keep some private notes on it containing other categories of information, could be fined five thousand dollars or put in jail for three years for doing it. That no one has been sent to jail under this particular law, is nothing to the credit of the law, nor the spirit in which it was passed. It is the sort of thing that makes the gum business more attractive to men of talent, and tends to supply a growing country with more chewing gum and fewer box-cars. All these circumstances and others too numerous and complex to state have hurt, not only the roads, but the public, and hurt both badly. It does seem as though it were time the American public grew weary of throwing things at the railroads. It might just as well go home and throw rocks at its own windows.

—From *The Independent.*

EFFICIENCY EXPERTS URGE WORLD METRIC STANDARDS

The nation-wide interest in the Britten-Ladd Metric Standards Bill, now before Congress, is evidenced by discussion of the metric issue in current business and industrial publications. A notable series of articles on "The Meaning of the Metric Move for Business and Nation," by A. Guyot Cameron, is now appearing in Forbes Magazine.

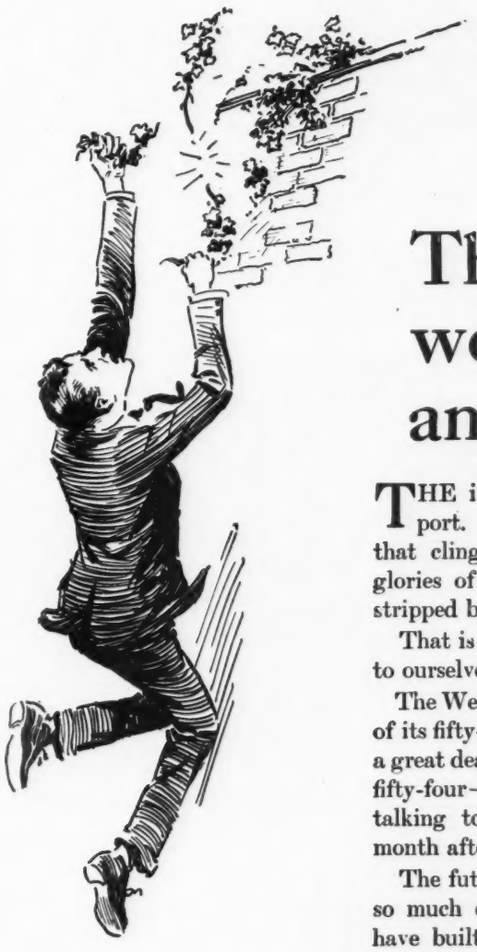
In his recent first article this authority points out that George Washington urged upon Congress the importance of standardization of weights and measures to conform with a world decimal system. That this advice has not been heeded, he declares, is a vast national loss.

"Why prate our business cry that Time is Money," says A. Guyot Cameron, "when we violate it by refusing the system that saves time and makes money?

"Opposition to metricism is based largely upon the supposed cost of the change to manufacturing. This has been disproved again and again by the greatest of manufacturers and engineers. The argument is plausible, but not practical, nor is it veracious. For the Metric Bill seeks only exclusive use of world metric units in merchandising, and leaves to the manufacturer his choice of units for production should he choose to oppose world standards. Could anything be fairer?

"Our political motto is *E Pluribus Unum.* Let us apply it to the sphere of economic calculations.

"Hundreds of great industrial concerns are urging metric legislation on the basis of the new bill, which protects the manufacturer."



The ivy won't save any of us

THE ivy of tradition is a slender support. A man or a team or a college that clings to it, harking back to the glories of yesterday, is likely to be outstripped by some young but sturdy rival.

That is a sermon we have taken home to ourselves.

The Western Electric Company is proud of its fifty-four years of history. But it is a great deal more concerned with the next fifty-four—and that is why we have been talking to the college men of America month after month now for four years.

The future of this business depends not so much on the physical equipment we have built up as on the mental equipment which men of your generation are building—on your habits of study and conduct, on your right choice of a profession and your proficiency in it. So we have made suggestions for your guidance, with the conviction that they can help you—and us.

* * * *

This company, with its laboratories, its distributing organization and its great telephone factory—in every respect a modern industry and in many respects a leader—will have openings from time to time for men who can qualify.

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

Western Electric Company

Since 1869 makers and distributors of electrical equipment

Number 36 of a series

PRINCIPLES OF FIRE PROTECTION

(*Continued from page 359*)

turally prepared as far as possible to resist the spread of fire, consideration must be given to the methods and equipment which shall be employed to extinguish fire.

Many fires are discovered in their incipiency and for the want of a handy pail of water much property has been needlessly destroyed. Inside hand fire extinguishing apparatus is needed to cope with small fires and such apparatus should be liberally installed. The various types of inside fire apparatus (exclusive of automatic sprinklers) are:

1. *Pails.* These are of twelve quart capacity and twelve are required for each five thousand square feet area; to be hung three or four feet from the floor. Three pails and one filled cask of at least sixty gallons capacity or one approved fire extinguisher and six pails to be considered the equivalent of twelve pails.

The water supplies to sprinkler systems are:

1. Municipal Water Works, *i.e.*, connections to street mains.
2. Gravity tanks or privately owned reservoirs.
3. Pressure tanks.
4. Steam pumps.
5. Centrifugal pumps.
6. Rotary pumps.

For standard protection two independent supplies are considered necessary. If anything happens to one supply there will be another one to rely upon. Water in street mains is frequently shut off to repair broken mains and for laying new ones. Should the sprinklers operate while such work is being done on the mains the second supply, a tank or pump, is immediately available to give the necessary supply of water. In the case of a large fire the secondary supply can be called upon to reinforce the primary. The first or primary supply should always be automatic and capable of giving a pressure of at least twenty-five pounds on the highest sprinklers.

Many buildings or sections of a building are not heated sufficiently to prevent freezing in winter. In such instances a "dry-pipe" system is installed. A dry-pipe system is one in which there is air under pressure in the sprinkler pipes instead of water. The flow of water into the pipes is controlled by a dry-pipe valve which is a device at the base of the system for holding back the water until a sprinkler operates and then opening automatically, allowing the water to flow into the pipes.

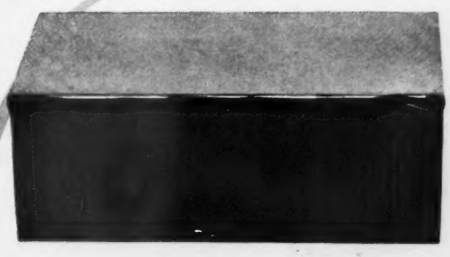
When the dry valve, or in the case of wet-pipe system, an alarm valve operates, their mechanism will actuate an alarm in the form of a large rotary gong located on the outside of the building and an electric gong inside. The ringing of the gongs signifies that there is water flowing through the system. A more elaborate system of "water flow" alarms is known as the Sprinkler Supervisory System. The purpose of these systems is to give notice at a central station that there is flowage in the pipes due to the opening of a sprinkler head or to a break. The systems when fully installed on all parts of the sprinker system will also give notice in case anything happens to impair its effectiveness, such as the closing of a gate valve, low water in a tank, etc.

The automatic sprinkler is a silent watchman on duty twenty-four hours of the day year after year guarding valuable property and lives against the ravages of fire. It may stand for years before being called into action to throw a downpour of water on a

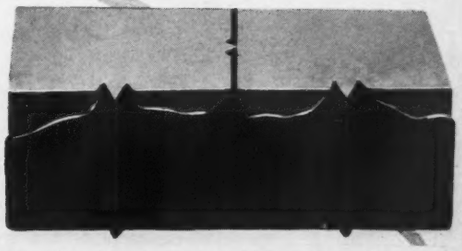
(*Continued on page 376*)

KREOLITE KOUNTERSUNK - LUG - BLOCKS

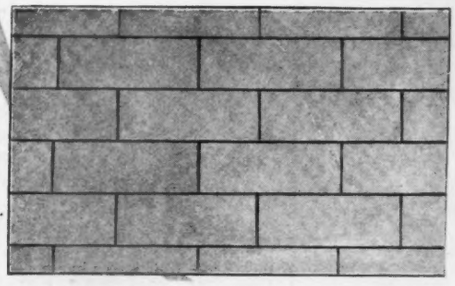
"The Paving that's Saving"



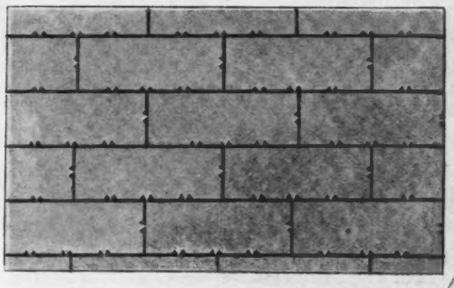
1—Showing imperfect penetration of filler with common rectangular block.



3—Showing nearly perfect penetration of filler with Kreolite Kountersunk Lug Blocks.



2—Plan view of plain or common rectangular blocks.



4—Plan view of Kreolite Kountersunk Lug Blocks.

KREOLITE Kountersunk Lug Wood Blocks are designed for bridge and street paving, and, with a slight variation of the kountersunk feature, for interior factory flooring.

This method of construction permits the penetration of the bituminous filler the entire depth of the block on all sides (see figure 3) securely binding it to the base and making a firm waterproof joint. The filler (our special make) is applied hot in liquid form and hardens when cool. The block cannot become loose because it is firmly attached to the base and to the adjacent blocks on four sides. In laying, only the tough end grain is exposed to wear.

In figure 2, the blocks make a good appearance, but is another case where beauty is only skin deep. The filler solidifies and fills only the upper part of the joint (see figure 1). Note bonding power, so essential to the permanence of any block pavement, as shown in figure 4.

To all City and County Officials, Contractors, Architects, Manufacturers, and others interested, we extend, gratis, the services of our trained engineers.

Write for detailed specifications and information

The Jennison-Wright Company, 79 Kreolite Bldg., Toledo, Ohio

Resistless Force— Controlled!

THE CHEMICAL ENGINEER has created, in explosives, a power that can blast a mountain or crack a boulder—dig an isthmian canal or drain a swamp.

Today, explosives power is employed both in the heaviest and in the most delicate operations. The scientific control of this resistless energy has enabled explosives engineers to utilize it in ways undreamed of a generation ago.

Recently at the Frazier Quarries of the Chesapeake & Ohio Railroad in West Virginia, 60,000 pounds of du Pont dynamite were exploded at one time to bring down *five hundred million pounds* of stone for ballast. Literally a whole hillside was blasted out.

But in a power house in Baltimore, du Pont explosives were used to perform a different and delicate operation. This work involved blasting out five concrete bases in the basement of the building without damage to a switchboard that governed the distribution of power over a large section of the city. While blasting was in progress a glass of water and some wire nails placed on their heads in an upright position near the blasts were not disturbed by the explosions.

So, in dynamite, we have a servant that will do our bidding in little things as well as big—a power that can be made to perform our work easier, better and cheaper in all industries.

The du Pont Company has been making explosives since 1802. With the development in explosives manufacture have come many improvements to expand the use of the product. And it has been the privilege of du Pont, through exhaustive research and experiment, to lead the way.

E. I. DU PONT DE NEMOURS & CO., Inc.
***Explosives Department*, Wilmington, Delaware**

DU PONT EXPLOSIVES

FIRE PROTECTION

(*Continued from page 374*)

nearby fire. But of what avail is a standard sprinkler system if there is insufficient or no water when it is most needed? A sprinkler system, to be effective, must be maintained in proper working condition at all times. An owner will spend eight thousand dollars or ten thousand dollars to install a complete system and then promptly forget it because its maintenance is not essential to the proper operation of his plant.

Sprinkler systems are emergency devices and are seldom called upon, but when the occasion arises they are then the most important devices in the building.

JAPANESE EARTHQUAKE

(*Continued from page 355*)

brick and terra cotta between steel columns, but considerably less than on the other buildings, also considerable of the terra cotta showed cracks on the upper floors and a few of the granite base blocks were cracked. No window glass was broken, but from the outside view there were indications that a portion of the hollow tile partition walls on first floor had fallen down.

Seiuyukai. Small damage as the walls were not cracked, but some damage from the fire caused by scaffolding burning, no indication however of any interior damage to partitions or walls, and work on this building can be resumed at once.

I am quite confident that the damage to our buildings will be found on examination to be much less than the damage sustained by other buildings that remain standing, with the possible exception of the Mitsubishi and Industrial Banks Buildings. All things considered our work in Tokyo has stood the test."

A complete index of Volume IV will appear in the last of this issue.

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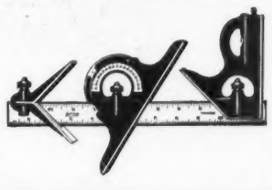

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ATLAS EXPLOSIVES

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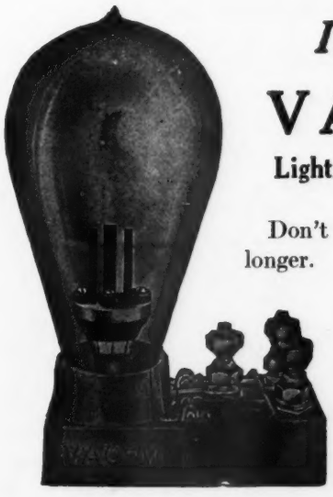

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THERE was a touch of black magic in the making of bronze bushing bearings when William Bunting poured his first molds sixty-two years ago.

He carried the formulas for his alloys in his head and in a little memorandum book which was never out of his possession. He gained his knowledge through years of patient endeavor, successes and failures.

Today his three sons and their sons manufacture Bunting Bushing Bearings in a great plant that gives scientific precision to the unique and exclusive methods originated by three generations of one family working constantly at one specific task.

Sixty-two years of progress are built into every one of the millions of Bunting Bushing Bearings going into mechanical industry today. The records, statistics, observations, tests and experiences of over a half century are reflected in the operation of a plant that admittedly stands alone in the quality of its product, the scope of its service and the efficiency of its methods.

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BUNTING BUSHING BEARINGS
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COPPER IN MODERN STEELS

(*Continued from page 353*)

found to withstand the exacting demands made upon them better if copper and nickel are constituents of the steel. Shafting of copper steel has met numerous specifications. For long periods rails have been made of steel bearing copper and have been found to be very desirable in service. Boiler plate of copper steel has noticeably outlasted plate of simple carbon steel. In the course of years there have been many failures of steels reported but records show surprisingly few if any causes of dissatisfaction to be due to copper as a constituent. Adequate homage must be paid to the exceptional resistance of copper steel to corrosion but, notwithstanding the factor of hardness, has had to be satisfied in all cases. These conclusions have not been founded on any limited series of tests. They are the fruits of years of experience in the manufacture of millions of tons of copper steels. It is quite certain that any detrimental influence of copper would have been discovered in the many investigations which have been made into the mechanical properties of this particular class of steels.

In this presentation and review of the effect of copper on the hardness of steels an attempt has been made to associate the purely theoretical conception of hardness with that property as it is measured by physical testing and which is so intimately connected with the industrial success of steels. Through the medium of the theory there exists a simple relation between copper and hardness. Physical testing verifies the theoretical conception but the connection between copper and hardness is less distinct to see. In industrial applications of steels the property of hardness as affected by copper is even more difficult to discern. Nevertheless, there is a similar relation which persists through each of these three separate considerations and that relation sustains the idea that copper in small percentages has the effect of making steel harder.

The Results of a study of the low-temperature carbonization of the Pittsburgh and Upper Kittanning coals, made by the Department of the Interior in coöperation with the Carnegie Institute of Technology at the Pittsburgh Experiment Station of the Bureau of Mines, indicate that the regular Pittsburgh bed coal is a good low-temperature coking coal. When carbonized at 550 degrees C. in a stationary vertical retort it will yield 33 to 35 gallons of tar, 3,500 cubic feet of 600 b. t. u. gas, 1,400 of 10 per cent volatile coke, and 6 to 8 pounds of ammonium sulphate per ton.

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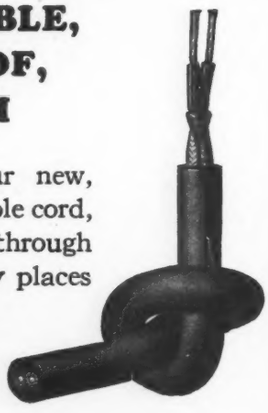

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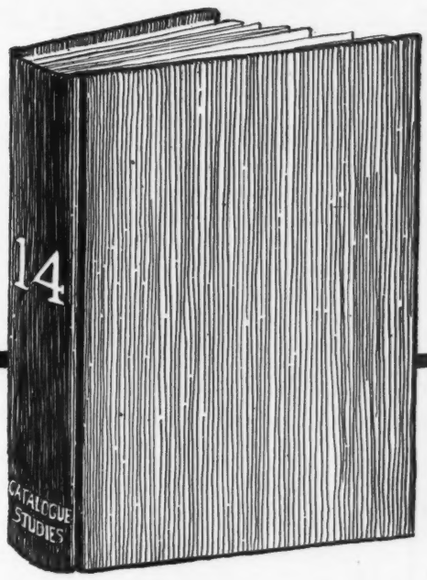
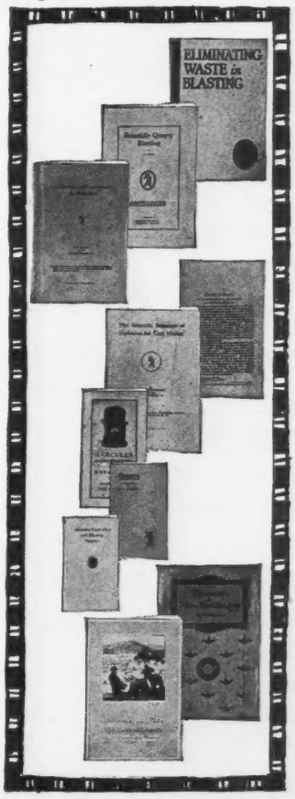
Ask your Librarian for Vol. 14 of Catalogue Studies to get complete information about the most economical and efficient use of explosives.



Vol. 14 of *Catalogue Studies* contains: "Eliminating Waste in Blasting", "Scientific Quarry Blasting", "The Scientific Selection of Explosives for Coal Mining", "Shot-firing by Electricity", "Land Clearing and Wood Utilization by Distillation", "Hercules Explosives and Blasting Supplies", "Flotation—A Brief Survey", "Hercules Galvanometers and Rheostats with Instructions for Their Use", "Dynamite—the New Aladdins Lamp", "Land Development."

Catalogue Studies

KNOWLEDGE of the use of explosives is an essential part of the training of every engineer. This knowledge is at your disposal in Vol. 14 of *Catalogue Studies*—a series of books containing the technical literature of the leading manufacturers of the country. If you are not already familiar with it, ask your college librarian.



Vol. 14 contains ten authoritative text-books (as shown in the illustrations on this page), published by the Hercules Powder Co., which tell in detail, with illustrations and diagrams, how, when and where to use various explosives most economically and efficiently and explain the development of dynamite from its origin to the present day.

The booklet on *Flotation* is especially interesting to mining engineering students who wish to know about the concentration of ore by the use of flotation oils.

In the booklet entitled *Hercules Explosives and Blasting Supplies* you will find a complete list of Hercules publications to date, any of which will be sent you on request. Furthermore, if there is any special subject connected with blasting which is not fully covered in these books, The Hercules Powder Company Library will gladly furnish you with a bibliography on receipt of your letter addressed to 941 King Street, Wilmington, Delaware.

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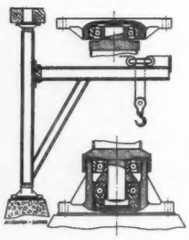

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ENGINEERING SALESMAN

(Continued from page 349)

he may find more opportunity to acquire irregular or questionable habits, but a good man can easily stand that test. As to the matter of brains, the more, the better, but good judgment and common sense and straight thinking are more needful than genius. Above all things, known your product and its uses. Be a student of the economics of your business. Make yourself so interesting and so helpful to the purchaser that you will naturally prevail over your competitors. It will surprise you how many of them will let you do it.

So it gets back of the first question. Are you to be an engineer or a commercial man, or perhaps a salesman in an engineering business? Some engineers are good business men, and are better engineers for it. And in an engineering business, at least, it would be hard to exercise good business judgment without having sound engineering knowledge. But a man usually excels in one direction or the other. If your talents and taste lie toward engineering, don't treat them lightly, for it is a great profession, and worthy of anyone's ambition if he can excel in it. It is no less true, however, that the occupation of selling requires just as definite qualities of fitness. Your biggest earning power can only be exerted in the kind of work that you best fit.

HIGH SPEED CAMERA

(Continued from page 361)

bends the shaft forward just before the club touches the ball, that is on the downward stroke the club shaft is bent backward, but as it nears the ball the shaft is bent in the opposite direction, that is, toward the ball.

But doubtless the most interesting subject which has been made with this camera so far is the flight of pigeons released from a basket. A study of this subject revealed that the pigeon's wings touch above his back and also around in front of him. The movement is much more like a swimming stroke than the popular conception of a flying stroke. It was also noted that on the back stroke the bones of the wings are bent at right angles, while on the forward-downward stroke the bones are straight from the body. An examination of the behavior of the feathers disclosed a very strong lifting propelling force at the trailing edge of the tip of the wings. Much better observed in motion pictures than in "still".

Doubtless there are many every-day activities all about us which would be worthy of more detail study.

London to Paris Air Service has been put on a strictly "pay as you ride" basis. The airplanes are to be equipped with taxi-meters which will operate on a fare of two shillings per mile. At this cost the clock will show a fare of about thirty-five dollars for each of three passengers travelling from London to Paris.

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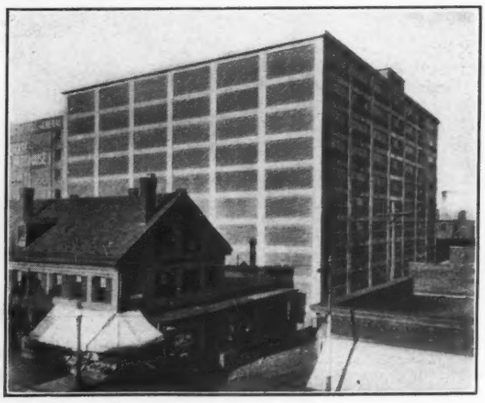

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The Wright T-3 Aeronautical Engine has the highest guaranteed horse power of any engine now in series production throughout the world.

In excess of this guaranteed power there is a comfortable margin still in reserve that is always immediately available.

This organization in bringing the model T engines up to their remarkable performance have been careful to take other stresses and strains induced by high power into consideration when completing design.

Thus are careful judgments in correct aeronautical engineering practice a part of the heritage of the Wright Aeronautical Corporation.

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The Wright heavy duty T engine installed in a U. S. Navy torpedo plane increased the power by about 150 H.P. This increased the service ceiling almost 90%, the rate of climb and take off 30% and the high speed over 10 miles per hour. The flight radius remained practically the same but the flying characteristics were greatly improved due to the reserve power.

RATINGS
T-2
525 H. P. heavy duty
Weight 1150 lbs.
T-3
550 H. P. heavy duty
650 H. P. high speed
Weight 1160 lbs.

WRIGHT MODELS T ENGINES

THE MOST PROBABLE WORLD

(*Continued from page 357*)

probably occur with the greatest frequency in a given number of trials. If the events are not purely random, the frequency curve will be symmetrically or unsymmetrically warped (skew), and of a certain definite type depending on the antecedent character of the data.

Again, if the events be weighted, as the dice are loaded in a crooked crap game, the event most likely to occur either simultaneously or most frequently, will have a marked preponderance. This fact may be illustrated by the series of symmetrically warped curves shown in Fig. 3. These curves may also be skew, and, in most actual cases will be so. Finally, the curve becomes a straight line, *A-B*, perpendicular to the axis of ordinates, and means that all the events of this class are likely to occur either simultaneously or to be alike.

We may look on all the well established laws of physics as describing classes of events having this last type. Needless to say, events of this type are rare in our whole possible experience of the world in time and in space, and insofar physics essays to describe a particular and limited order of the entire behavior of things. Indeed it may be true that there are no cases of this type, and that we have mistaken a very marked probability for a certainty.

The totality of all the possible or probable cases falling within the scope of a law of physics may be visualized as the area under the appropriate frequency curve, and which represents all the actual and ideal cases. This area is properly described in mathematical terms as an infinite series, the principal term of which covers the most probable case so well illustrated in the Mendelian law of heredity. But the law of heredity, precisely as in the case of any other frequency distribution, is of the discontinuous character illustrated by the graph in Fig. 1, and not of the ideal continuous form shown in Figs. 2 and 3 which take into account all possible cases, measurable and incommensurable, real and ideal, and therefore assume a continuity of the data which, in no real case, does it possess. The discontinuities in Fig. 1 result from the essential discreteness of the given data.

It remained for Planck to point out that a similar discreteness must exist in the data from which any law of physics is deduced. Thus, if the distribution of energy among, or its emission by, the electrons, atoms or molecules of any substance is to be computed from the standpoint of probabilities, then the subdivision of this energy, like the facets of a polyhedron, must have an ultimate fineness, and must appear only in discrete quantities. These Planck called *energy quanta*. On whatever the ultimate subdivision of energy into such quanta actually depends, the result of this seemingly obvious conclusion has been to release physical theory from the bonds of continuity, precisely as the recent work of the great arithmeticans, Peano, Dedekind, Cantor, Russell and others has liberated mathematics from the trammels of false notions as to the meaning of zero and infinity.

From this point of view, the law of inverse squares may be looked upon as the first and most important terms in a series, of which the remaining terms, and perhaps only one or two of them, so far as our ordinary experience of things goes, may become of importance, under conditions very special in relation to those ordinary events to which the first term applies satisfactorily. Thus, other terms may come in when the distance between the mass centers is either extremely small or extremely great, relatively to those cases for which the law was originally developed. The electron theory of atomic structure as given by J. J. Thomson, and Einstein's theory of gravitations are alike in this, that both contemplate the addition of further terms to the mathematical expression of the law of force forming the basis of Newtonian dynamics. Indeed it is obvious that unless we find that mass is not associated with substance, in the end, the law of universe squares must prove to be an approximation. The law assumes the existence of point-masses, but every possible mass must actually occupy a definite amount of space, A mass cannot be concentrated at a point, for a point is of no dimensions. Therefore, the error in considering a mass as concentrated at a point will be of the second order and insignificant only when the measured check of the implications of the assumption is made at a considerable distance from the point relative to the dimensions of the space actually occupied by the mass. In his "Geometrical Theory of Radiating Surfaces," (Bureau of Standards Bulletin, Vol. 3, Number 1) E. P. Hyde has shown that the error

(*Continued on page 384*)

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AMERICAN SHEET AND TIN PLATE COMPANY, Frick Bldg., Pittsburgh, Pa.

BRINGING MORE DAYLIGHT INTO INDUSTRIAL BUILDINGS.

Dr. George M. Price, writing on "The Importance of Light in Factories," in "The Modern Factory," states: "Light is an essential working condition in all industrial establishments, and is also of paramount influence in the preservation of the health of the workers. There is no condition within industrial establishments to which so little attention is given as proper lighting and illumination. Especially is this the case in many of the factories in the United States. A prominent investigator, who had extensive opportunities to make observations of industrial establishments in Europe as well as in America, states: "I have seen so many mills and other works miserably lighted, that bad light is the most conspicuous and general defect of American factory premises."

"My own investigations for the New York State Factory Commission support this view. In these investigations it was found that 36.7% of the laundries inspected, 49.2% of the candy factories, 48.4% of the printing places, 50% of the chemical establishments, were inadequately lighted. There was hardly a trade investigated without finding a large number of inadequately lighted establishments."

Inadequate and defective lighting of industrial buildings is not confined to the establishments in New York State alone. The same conditions prevail in most sections of the country.

Such conditions as mentioned above are entirely opposed to the laws of health, sanitation and efficiency. Wherever poor lighting conditions prevail, there must be a corresponding loss of efficiency and output both in quality and in quantity. American industry is not using nearly enough daylight and sunlight in its buildings. Every endeavor should be made to use as much as possible of daylight for lighting purposes. To obtain this it is of course necessary that the rays of daylight and sunlight are permitted to enter the interior of the buildings as freely as possible, with the important modification that the direct rays of the sun must be properly diffused to prevent glare and eyestrain. A glass especially made for this purpose is known as Factrolite, and is recommended for the windows of industrial plants. Windows should be kept clean if the maximum amount of daylight is to pass through the glass, but the effort will be well repaid by the benefits secured.

In the presence of poor lighting, we cannot expect men to work with the same enthusiasm as when a well lighted working place has been provided. The physical surroundings have a deep effect upon the sentiments of the employes, and where bad working conditions are allowed to prevail, there is invariably a lessening of morale and satisfaction created thereby. Neglecting to utilize what nature has so bounteously provided, daylight, and which is so essential toward industrial efficiency, we have an instance of wastefulness, but now that the importance of good lighting is becoming recognized, undoubtedly more attention will be given by progressive industrial employers to furnishing the means which are essential for their workers to secure and maintain the efficiency, which counts for so much in the success of any industrial concern in this competitive age.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York, Chicago.

Good Friends from now on

THERE'S good news at the plant. The production engineer and the chief inspector have buried the hatchet—their feud is ended—and all because of Ground-Form Cutters.

For months Jones, the engineer, thought that big Mac, the chief inspector, was rejecting gears in order to give production a black eye.

"They're good gears, Mac," protested Jones. "What's the matter with them?"

"Sure they're good, if you take them one by one," replied Mac, "but in big lots they're not uniform enough to pass inspection."

And so the war began; Mac grew more careful, and Jones felt sure that Mac had a personal grudge against him.

Then Jones discovered Brown & Sharpe Ground-Form Gear Cutters. He heard that they would increase production and at the same time improve the quality of his gears. He tried a few. Now, all his gear cutting machines are equipped with Ground-Form Gear Cutters.

Mac and Jones are good friends now. Gears come through faster than ever and rejections are few and far between.

Here is the booklet that proved so valuable to Jones. You can avoid his difficulties by getting acquainted with Ground-Form Cutters before the full responsibility of production falls on your shoulders. Write today for your copy of this instructive booklet.

BROWN & SHARPE MFG. CO.
Providence, R.I., U.S.A.

Manufacturers of

Milling — Grinding — Gear Cutting — Screw Machines
Cutters and Hobs Machinists' Tools

THE MOST PROBABLE WORLD

(*Continued from page 382*)

introduced by assuming a radiating circular source to be equivalent to a radiating point is reduced to approximately 1.0% only, when the distance measured normally from the center of the source is five times its radius.

The point to get into your mind is that laws of physics are only probably true and not certainly true, just as the theorems of Euclidian geometry are true in a space of the kind defined by the Euclidian postulates, so the law of physics is true only for a world whose fundamental physical nature is as assumed and set up as a postulate for theoretical physics. The danger is, that habitual thinking in accordance with such laws may induce a sort of mental sclerosis that inhibits progress. Our assumption that physical space is Euclidian becomes a fixed conviction. It seems necessary to us that the physical world be a mere counterpart or definite embodiment of the commonly accepted physical theory.

The systematic analysis and discussion of probabilities, the so called calculus of probabilities, is misnamed. It is the most accurate method of calculation known. Actually it is the only method of calculation that takes for its postulates the more or less random character of the phenomena which, from craps to astronomy, make up the detail of this world. It assumes nothing as fixed, given, or absolute, and in this, if our argument has carried conviction, the formulæ of probabilities are very descriptive of the world's behavior. It *is* the most probable world.

Shock from "B" Batteries. There is ample current capacity in dry cell batteries to produce a fatal shock, but ordinarily the voltage is not sufficient to force this fatal shock through the body. Some "B" batteries, however, have as high as three hundred and fifty volts which would cause a severe and possibly a fatal shock to anyone coming in contact with both main terminals when making or breaking the connection.

Directive Type of Radio Beacon. Recently an airplane flew to Dayton from a point a hundred miles away, the pilot depending for guidance entirely upon the signals received from a new type of radio beacon. In his receiver he heard the letters *A* and *T* repeated over and over. As long as he flew along the correct course both letters were equally loud, but the moment he got off the course to one side or the other one letter became noticeably louder than the other and showed him which way to turn to get back. An ordinary airplane receiving set was used.

This beacon, which was developed by the Bureau of Standards, consists of two coil antennas placed so as to cross each other at an angle of 135 degrees. Each consisted of a single turn of wire 100 feet long and 50 feet high. The transmitting set is automatically connected first to one and then to the other, one letter of the signal being sent over each. The signal from an antenna of this type varies from a maximum in the plane of the coil to almost zero at right angles. A receiving set located along the line bisecting the angle between the coils will therefore receive signals of equal intensity from both, and the ship or airplane carrying the receiving set can thus be guided along this line in either direction, and without regard to conditions of visibility.

BUFF Instruments

save time — error and calculation

Engineers and contractors know that BUFF performance is accurate and sure — on all sorts of work from running location lines to giving "neat lines" on important bridge work—without having to adjust the transit once.

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